SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1924.

GENERAL PHYSICS.

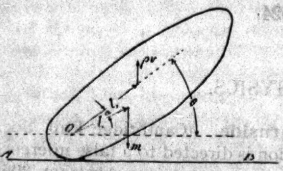
1330. *Errors of Observation.* **W. Burnside.** (Cambridge Phil. Soc., Proc. 22. pp. 26–27, Feb., 1924.)—Attention is directed to a false inference drawn from the analysis given in a previous paper [see Abstract 2066 (1923)]. The revised probability statement given in the present paper gives no direct justification for a probability statement which is concerned with one, and only one, set of observations, apart from any assumption regarding their probabilities before the observations. A. B. C. L.

1331. *Ultimate Rational Units.* **N. Campbell.** (Phil. Mag. 47. pp. 159–172, Jan., 1924.)—The author criticises Lewis's theory of ultimate rational units, which, he argues, is demonstrably erroneous. Its falsity has its origin in a failure to observe that the equations by which Planck proposes to determine his "natural units" from universal constants are usually indeterminate [Abstract 1005 (1923).] T. H. P.

1332. *Report of the Physikalisch-Technischen Reichsanstalt for* 1923. (Zeits. Instrumentenk. 44. pp. 73–138, March, 1924.)

1333. *Ferguson Density Meter, No.* 5. **W. B. Ferguson.** (Phot. J. 64. pp. 30–35; Disc., 35–36, Jan., 1924.)—The instrument is intended for the measurement of photographic densities to non-parallel rays (D_n), being a modification of the long bench photometer type, but of manageable length, and with an improved comparison field through the use of a modified Abbé cube and a magnifying eye-piece. The author describes the devices for putting it quickly in adjustment, and the means by which higher densities can be read than from 0·0 to 2·5, which are given by the scale. In the *discussion* which followed, it was agreed that its great advantage is the equality of illumination of the field whatever the density measurement; but objection was taken to the use of the two lamps (instead of one), involving perpetual electrical adjustment; of a vertical plate-holder instead of a horizontal one, which is necessary for rapid working; and of an opal screen, which, by scattering the light, might bring about a variation with distance from the lamp, and so alter the densities slightly. A. S. D. M.

1334. *Total Immersion Indicating Hydrometer.* **A. Pollard.** (Journ. Sci. Instruments, 1. pp. 97–104, Jan., and pp. 129–136, Feb., 1924.)—A description of an instrument where one end rests and rolls on a horizontal optical flat whilst the other moves over a circular calibrated scale, the configuration and disposition of the material from which the instrument is made being such that the centroid of its mass m and the centroid of its volume v subtend a small angle α at the instantaneous centre of rotation. If θ be the angle l_2 makes with the horizontal in the position of rest, then $\tan\theta = A\rho - B$, in which A and B are constants depending on the configuration of the body, A also being dependent upon the temperature. If the observed reference line subtends an angle β with the line l_2 at the centre O, the angle which is observed will be $\phi = \theta \pm \beta$. After giving the theory of the instrument, the author states that the sensitivity is greater the smaller the angle α and is a maximum when $\phi = \beta$ or the imaginary line l_2 is horizontal. The observed angle, as already stated, is $\phi = \theta + \beta$. When A, B, and β are known, by plotting the tangents of $\theta = (\phi - \beta)$ against the corresponding densities, the best straight line, known as the *calibration line*, can be fitted to the three observations from which the scale can be constructed. The tangent of the inclination of the instrument to the horizontal when in equilibrium is proportional to the densities, and to demonstrate these points two actual instruments are described, with illustrations. The author proceeds with the development of high-sensitivity precision instruments requiring temperature control, and shows how by their use the density of highly viscous liquids, such as glycerine, can be determined comparatively rapidly. The cubical coefficients of expansion of liquids can be directly determined.



T. C. H.

1335. *The Density of Graphite.* **E. Ryschkewitsch** and **E. Köstermann.** (Zeits. Elektrochem. 30. pp. 86–88, Feb., 1924.)—The density of carefully prepared graphite at 16° C. is 2·232 gr. per c.c. Within the limits of error this agrees with the value deduced by Debye and Scherrer from X-ray measurements.

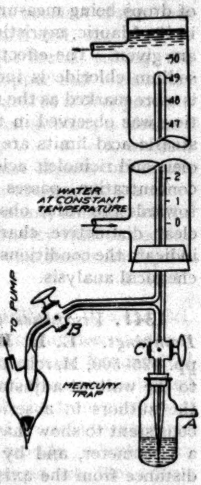
A. A. D.

1336. *Mensurational Characteristics of Photographic Film.* **F. E. Ross.** (Eastman Kodak Co. Research Lab. Comm., No. 192. Astrophys. J. 59. pp. 181–190, April, 1924.)—The observation of Cheshire and of Curtis, that photographic film is subject to large and irregular contraction on development, is confirmed only in the case of "NC" or non-curling film. For motion picture, aerial, portrait, and process film, the contractions and irregularities are found to be considerably less; in the two last mentioned, only one-tenth (about 0·05 per cent.) of those found by Cheshire and Curtis. The changes in length and width are different, the length of a film showing increased effect, due probably to strains in the roll. Films of all kinds are subject to parallel changes in length from day to day and from winter to summer, due to humidity conditions. There is no local distortion in portrait film or in motion picture and aerial. Local distortions of 10 μ sometimes appear in "NC" film on development, which, however, gradually disappear in a few days.

AUTHOR.

1337. *Surface Tension of Gelatin Solutions.* **C. E. Davis, H. M. Salisbury,** and **M. T. Harvey.** (Indust. and Engin. Chem. **16.** pp. 161–163, Feb., 1924.)—The surface tension of gelatin solutions is investigated by means of the Morgan drop-weight method. Increasing concentration causes decrease in the drop weight. The drop weight rises to a maximum with increasing temperature, and than falls until the transition temperature 38° C. is reached, when it remains constant. With increasing *p*H values, the drop weight tends to reach a minimum at 38° C. for all concentrations. If the solution is first heated to above the transition temperature, determinations may be made up to about 10 per cent. gelatin. The drop weight diminishes slowly with the age of the solutions. B. W. C.

1338. *The Accurate Calibration of Capillary Tubes.* **K. J. Isaac** and **I. Masson.** (J. Phys. Chem. **28.** pp. 166–169, Feb., 1924.)—The capillary tube is set up vertically with the portion to be calibrated surrounded by a water jacket, perferably maintained at the temperature at which the capillary tube is to be employed subsequently. The lower part of the capillary is provided with a tap C, and the lower end is drawn out to a very fine jet. A side tube communicates with a tap B, a mercury trap, and a vacuum pump. Calibration of the tube is carried out by exhausting the tube to various pressures and determining, by weighing, the respective amounts of mercury withdrawn from the vessel A when the mercury meniscus stands at different points on the scale attached to the capillary tube. Schalkwijk's data are utilised in order to ascertain the correction of volume to take account of the form of the meniscus (Phys. Lab. Leiden, Comm. No. 67, 1901, K. Akad. Amsterdam, Versl. p. 462, 1900, and p. 512, 1901). J. S. G. T.



1339. *Determination of Surface Tension from the Maximum Pressure in Bubbles. Part II.* **S. Sugden.** (Chem. Soc., J. 125. pp. 27–31, Jan., 1924.)—An improved form of apparatus is described and a simpler method outlined for calculating the surface tension from the observed data [see Abstract 2040 (1922)]. Direct measurement of the diameter of the capillary tube may be avoided by using pure benzene, the surface tension of which is known sufficiently accurately, for purposes of calibration; a table given shows the surface tension of benzene at temperatures from 10° to 30°. For tubes of the ordinary size, the equation

$$\gamma = A \, . \, P\left(1 + 0 \cdot 69 r_2 \frac{gD}{P}\right)$$

may be used, γ being the surface tension in dynes per cm., A a constant for the particular apparatus, P the difference between the pressures required to liberate bubbles from the two tubes in dynes per sq. cm., D the density of the liquid, and r_2 the radius of the wide tube in cm. T. H. P.

1340. *Surface Tension at the Surface of Separation of Water and an Organic Liquid in the Presence of Fatty Acids and Alkalis.* **R. Dubrisay and P. Picard.** (Comptes Rendus, 178. pp. 205–208, Jan. 7, 1924.)—In a preceding note [see Abstract 383 (1924)] the authors have described the influence of the carbonation of the alkalis and of the addition of certain electrolytes on a phenomenon discovered by Donnan and utilised by Dubrisay in acidimetry. In this paper is described the influence of the nature of the fatty acids employed and of their concentration in the organic liquid. The phenomenon only shows itself in the case of fatty acid properly so called. The different terms of the series are compared together. A fixed proportion of acid, 0·5 %, was dissolved in benzene and into this solution was made to flow slowly standardised soda liquids of strengths N/1250 and N/2500, the volume corresponding to an invariable number of drops being measured. The results for pure benzene and for solutions in it of lauric, myristic, palmitic, stearic, oleic, erucic, and ricinoleic acids are given. The effect of introducing in the aqueous phase 1 per cent. of sodium chloride is indicated. For the saturated acids the phenomenon is more marked as the molecular weight increases. The effect of concentration was observed in the cases of stearic, oleic, and ricinoleic acids. For stearic acid limits are set by the solubility of the acid in benzene. For oleic and ricinoleic acids the surface tension first decreases with increasing concentration, passes through a minimum, and again increases tending towards the value observed in the absence of alkali. The results furnish clear distinctive characters peculiar to the different fatty acids, and indicate the conditions for obtaining the maximum of sensibility in physico-chemical analysis. J. J. S.

1341. *Viscosities of Liquids Experimentally Correlated to Pendulum Dampings.* **E. H. Barton and H. M. Browning.** (Phil. Mag. 47. pp. 495–500, March, 1924.)—Plates dipping into tanks, and swinging near to the wall, at adjustable distances, were fixed to the pendulums used by the authors in a series of recent papers. The results were sufficiently consistent to show that it would be possible to use this method to construct a viscometer, and by suitably varying the size of the plates, and their distance from the axis, the apparatus could be made to deal with a wide range of viscosities. W. G. B.

1342. *Capillary Tube Viscometers.* **G. Barr.** *Part I.* (Journ. Sci. Instruments, 1. pp. 81–86, Dec., 1923.) *Part II.* (Ibid. pp. 111–116, Jan., 1924.)—A discussion of the principles underlying the construction and use of viscometers in which the viscosity of a liquid, *relative* to that of some standard, is estimated from the resistance offered by a tube to the flow of the liquid through it. The well-known extended form of the fundamental equation of Poiseuille

$$\eta = \pi r^4 Pt/8v(l + nr) - m\rho v/8\pi t(l + nr)$$

(where η = viscosity of liquid, r = radius of tube, l = length of tube, P = time average of effective pressure difference causing flow, ρ = density of liquid, v = volume of liquid flowing through the tube in time t, m and n are constants) may be written $\eta = \mathrm{A}Pt - \mathrm{B}\rho/t$ where, for a given instrument, A and B are constants to be determined by the use in it of two different standard liquids. If the time of flow, t, is sufficiently long, the second term on the right-hand side may be made negligible, and the calibration of the instrument then involves the use of only one standard liquid. The first part of the paper is devoted to a discussion of this second, or kinetic energy, term, and, in particular, the determination of the maximum diameter of the capillary tube which can be employed in the construction of an instrument for which the term may be neglected in the measurement of viscosities over a given range. The second part of the paper proceeds to discuss (*a*) the mean head obtainable in Ostwald viscometers (the reduction of the mean head in order to allow the use of the widest possible capillaries for liquids of low viscosity cannot be carried too far); (*b*) volume of upper bulb; (*c*) drainage errors; (*d*) ranges of viscometers. M. A. G.

1343. *Reliable Works Viscometer.* **M. Marasco.** (Indust. and Engin. Chem. 16. pp. 172–173, Feb., 1924.)—This instrument consists of a rubber (or metal) bulb with a short tubulated orifice at each end, one of these being fitted with a short length of capillary glass (or metal) tubing, the other end of which fits into the hole of a rubber stopper and terminates flush with the lower surface of the stopper. The apparatus is dropped into the liquid to be tested, the time t required for submersion being a measure of the viscosity. If V is the viscosity in centipoises, $V = at - b$, where a and b are constants obtained by calibration against liquids of known viscosities. Since the force tending to submerge the viscometer is a function of the weight and specific gravity of the instrument, and also of the specific gravity of the liquid to be tested, a specific gravity-time correction curve must be constructed if it is desired to use the viscometer for liquids varying in specific gravity. T. H. P.

1344. *Simple Viscometer for Gases.* **A. O. Rankine.** (Journ. Sci. Instruments, 1. pp. 105–111, Jan., 1924.)—The instrument described was devised in 1910 [see Abstract 1387 (1910)], but experience has resulted in certain minor changes of procedure and theory, and these are embodied in the present account. The underlying principle is the transpiration of the gas through a capillary tube, but it has been found possible to introduce considerable simplifications. The apparatus is readily adapted for measurements at different temperatures, and advantages are, that only a small quantity of gas is required, so that rare gases may be used, and, in any case, there is no need to purify much, and, further, once the apparatus is filled, repeated determinations may easily be made. The instrument is more suited for comparative than absolute determinations, the accuracy in the former case being about one in a thousand, and in the latter about 0·5 per cent. Details are given of the preparation and use of the apparatus. M. A. G.

1345. *Bifilar Quartz Fibre Manometer.* **A. S. Coolidge.** (Am. Chem. Soc., J. 46. pp. 680–681, March, 1924.)—Improvements on the author's manometer [Abstract 2045 (1923)]. Incidental remarks, supplementing the main paper. A. D.

1346. *Acoustic Probes.* **Z. Carrière.** (J. de Physique et le Radium, 4. pp. 413–419, Nov., 1923.)—Describes apparatus for "sounding" the instantaneous velocity and pressure at any point of a given space in which there is an acoustic or other disturbance. Pressure diagrams more accurate than those given by Watt's indicator can be obtained. Other industrial applications are indicated. G. A. S.

1347. *A Metal-to-Glass Joint.* **H. N. Ridyard.** (Am. Chem. Soc., J. 46. pp. 287–290, Feb., 1924.)—Details are given for coating soft glass, hard glass, silica or glazed porcelain with homogeneous lead films and for soldering material, so coated, to metal. [See Abstract 2 (1924).] W. V. M.

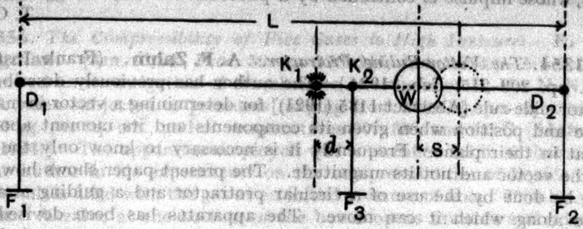
1348. *New Types of Levelling Instruments using Reversible Bubbles.* **T. F. Connolly.** (Optical Soc., Trans. 25. 1. pp. 21–35; Disc., 35–37, 1923–1924.)—The paper describes the properties of reversible bubbles which can be used both graduated and ungraduated. Making use of certain of such properties, it can be shown how a true level can be obtained as the mean of two observations from a single station in an extremely simple manner. The theory is then applied to the design of various types of " self-adjusting " levels. A series of actual levels, following the author's theory and specially made for the paper, are illustrated. A specification for an ideal level, using the same theory, is given. The author also deals with the application of a reversible bubble to the adjustment of a collimator. AUTHOR.

1349. *Accuracy of Mollenkopf Spirit Levels.* **H. Löschner.** (Zeits. Instrumentenk. 44. pp. 1–12, Jan., 1924.)—Two Mollenkopf spirit levels are tested. In the case of the rough level the error in setting is 5″, for the precision level the error is 1·5″. Neither type has adjustment screws, but the departure from perfection in adjustment is very small. For horizontal testing it amounts to only 10″ in the longitudinal section of each level, and ¼′ and 1¼′ in the cross-sections of the precision and rough levels respectively. The corresponding figures for vertical testing are 1½′ and 2¼′ in the long sections and 19″ and 8¼′ in the cross-sections. G. A. S.

1350. *Chronometers.* **H. Bock.** (Zeits. Instrumentenk. 44. pp. 22–27, Jan., 1924.)—A careful study of the effect of the oscillations of the mainspring upon the rating of a chronometer. Even with frictionless motion there must be a distinct anisochronism. A. D.

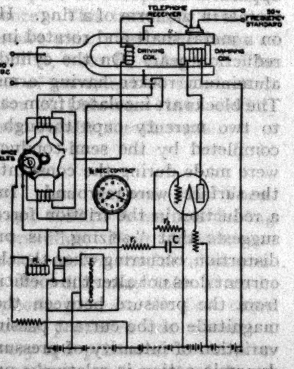
1351. *Foucault's Pendulum.* **F. Harms.** (Phys. Zeits. 25. p. 96, Feb. 15, 1924.)—A simple arrangement, with a long light-pointer, for demonstrating a change of the relative plane of oscillation from one oscillation to the next. A. D.

1352. *Calibrating Single-Lever Testing Machines.* **C. Jakeman.** (Journ. Sci. Instruments, 1. pp. 120–122, Jan., 1924.)—In the standard type of testing machine, consisting of a single lever resting on a knife edge and provided with a sliding weight where the upper end of the test piece is attached to a second knife edge upon the lever, there are two sources of error: (1) The distance between the knife edges and (2) the value of the jockey weight. Whatever the calibration shows, it is not possible to alter the knife-edge distance, but it is always possible to adjust the jockey weight to the required value to give correct indications on the machine. Two additional suspended scale pans F_1, F_2, are provided upon the lever at D_1 and D_2 respectively, as distant as possible to make known alterations to the moment. In addition, two or three 100-lb. weights for which corrections are known, a number of accurate 2-lb. weights, and an accurate set of weights from 1 lb. to 0·001 lb. are required. In the diagram L is the measured distance between the auxiliary suspension points D_1, D_2, d the distance between the knife edges K_1, K_2 to be determined, S the shift of the jockey, and F_3 a scale pan attached to the loading shackle. The author gives examples of the determination of



W and d from the formulæ $W = M_1 \times L/S$, where M_1 is the total mass moved from F_1 to F_2; and $d = L \times m/M_2$ where m is the sum of the weights removed from F_2 to F_1 and M_2 is the total mass hung from F_3.
T. C. H.

1353. *Clock-Controlled Tuning Fork as a Source of Constant Frequency.* **J. G. Ferguson.** (Bell System Techn. J. 3. pp. 145–157, March, 1924.)—The fork is operated by a driving magnet and make-and-break contact. It can be adjusted to operate at 50 cycles and is designed to drive a synchronous distributor that rotates once for every 10 cycles of the fork. By a 5 to 2 reduction gear and a contact operated by it an impulse may be obtained once every 25 cycles of the fork. If the fork oscillates at exactly 50 cycles per second, the time interval will be exactly 0·5 sec., this time interval being shorter or longer as the speed of the fork increases or decreases. The diagram shows the details of the control. When the clock contact closes, the relay operates and locks till the fork contact closes, short-circuiting the winding of the relay, which then releases. While the relay is operating, the condenser C is charged through the resistance r, by the battery B, the voltage of which is such that when applied to the grid of a vacuum tube will reduce the space current to zero. The condenser C continually discharges through the resistance r_2. The mean potential of the condenser, applied to the grid of the vacuum tube, modifies the space current, which is passed through the damping coil of the fork. The change in frequency of the fork due to the current in the damping winding is a combination of several effects which the author describes. Any change in the ratio r_2/r_1, such as might occur with temperature, will change the phase relation between the fork and the clock. After the phase angle has been once adjusted, hunting is practically precluded. The maximum variation of the fork from the clock over a period of



8 hours was found to be less than 0·02 sec., or one cycle. Methods of ascertaining the accuracy of the fork and the clock are given in detail, and a new type of clock mechanism consisting of an electrically actuated pendulum, whose impulse is controlled by a photoelectric cell, is suggested.

T. C. H.

1354. *The Vector-Ruling Protractor.* **A. F. Zahm.** (Frank. Inst., J. 197. pp. 209–215, Feb., 1924.)—The author has previously described a vector slide-rule [Abstract 1185 (1921)] for determining a vector in magnitude and position when given its components and its moment about a point in their plane. Frequently it is necessary to know only the line of the vector and not its magnitude. The present paper shows how this can be done by the use of a circular protractor and a guiding straight edge along which it can move. The apparatus has been devised for aeronautical work.

A. E. C.

1355. *Friction between Sliding Surfaces and Effects Produced by Electric Currents Passing Across such Surfaces.* **H. M. Barlow.** (Inst. El. Eng., J. 62. pp. 133–159, Feb., 1924.)—After a brief survey of other work on the passage of electricity across an imperfect contact, the author describes apparatus for measuring the variation in the normal presence at a sliding contact when carrying a current. Two arrangements, the "torsion" and the "steelyard" were used. In the torsion apparatus the sliding parts consist of two concentric flat rings; the upper attached to a torsion wire while the lower is supported on a horizontal table rotated by a motor, the twisting force due to friction at their contact being measured by revolving the torsion head until the top ring is brought back to its position when freely suspended. The active parts are enclosed in a gas chamber having an oil seal to allow relative motion. Current is led to the upper contact ring through a mercury trough. Other details of the apparatus, and the preparation of the rubbing surfaces are described. The steelyard apparatus was devised to meet the difficulty in obtaining certain non-metals in the form of a ring. Here a semi-conducting cylinder is mounted on a metal shaft and rotated in a horizontal plane by a motor, through a reduction gear. On the cylinder rest two brake blocks attached to an aluminium rocker having arms, and projecting in opposite directions. The blocks are insulated from earth and from each other, but are connected to two mercury cups through which current passes, the circuit being completed by the semi-conductor. All the experiments on the metals were made during the constant friction state, and when seizing occurred the surfaces were reground. In certain cases the influence of heat caused a reduction in the friction forces, *e.g.* copper and graphite. The author suggests that "seizing" is probably an exaggerated form of surface distortion, occurring when the elastic limit has been exceeded. The electric current does not alter the coefficient of friction but merely adds or subtracts from the pressure between the surfaces an amount depending on the magnitude of the current passing. Several curves are given to show the variation of intensity of pressure with current. The influence of electrodynamic action is relatively negligible. Several special cases are given of various contacts. The author investigates the nature of the "stiction" and slipping effects and goes very fully into the theory under various sub-headings. He concludes that materials such as slate, red fibre, etc., can only be classed as dielectrics in virtue of their high contact resistance, and that the true body conductivity of these semi-conductors cannot be measured with mercury electrodes. The paper ends with a description of experimental work on, and the theory of, the electrical effect at stationary contacts. T. C. H.

1356. *The Compressibility of Five Gases to High Pressures.* **P. W. Bridgman.** (Am. Acad., Proc. 59. pp. 173–211, Jan., 1924.)—A detailed account of an investigation of the changes in volume of H, He, N, NH_3, and A when subjected to pressures ranging from 3000 kg. per sq. cm. to 15,000 kg. per sq. cm., and at temperatures 30°, 65°, and 95° C. [Abstract 379 (1924)]. The apparatus employed was a modified form of that used by the author in his experiments on the compressibilities of liquids. A steel bomb is filled with the gas at an initial pressure of about 2000 kg. per sq. cm. A valve at the bottom of the bomb opens inwards and admits kerosene from a surrounding compression cylinder. The pressure is measured by the change in electrical resistance of a manganin coil, and the change in volume of the gas from observations of the position of the compressing piston. Although the experiments at the three temperatures do not admit of an exact evaluation of the thermal expansion coefficient of these gases, yet it seems probable that the coefficient remains large at the high pressures. The tables of results and curves given in the paper include graphic representations of—(1) The vol. in c.c. per mol. as a function of the pressure. Over the range 3000 to 15,000 kg. per sq. cm. the values for N vary from 36 to 25 c.c. per mol., for H from 24·4 to 15·5, and for He from 22·2 to 11·8. The gaseous densities under the highest pressures are such that the molecules or atoms are nearly in contact from the standpoint of the kinetic theory. (2) Compressibility as a function of pressure. As the pressure increases the compressibility approaches that of ordinary liquids under the same pressure. Helium shows the greatest change and N the least over the range of pressures employed. This may be accounted for by the compressibility of the atoms or molecules themselves, N being complex as compared with He. (3) The product *pv* as a function of pressure. This increases with the pressure being slightly concave to the pressure axis. Over the range of pressures the increase in the product is 16 for N, 9 for H, 6 for He. The results are compared with various equations of state, but no satisfactory agreement is found. Becker's equation for N [Abstract 1801 (1921)] approaches most closely to the experimental results for this gas.

L. L.

1357. *Experiments on the Effusion of some Vapours.* **E. Voss.** (Ann. de Physique, 20. pp. 66–110, July–Aug., 1923.)—A memoir dealing with the effusion of vapours through small openings. Four vapours were studied: Water, benzene, carbon tetrachloride, and monochlorobenzene. The effusion through small openings in a thin disc may take place in various ways: (1) In the region of atmospheric pressure the flow takes place with adiabatic expansion; (2) at lower pressures one obtains a flow under isothermal conditions; (3) at very low pressures the effusion is molecular. The regions where the different types of flow are produced are separated by zones of mixed effusion. The experiments described in this paper bear on the flow under isothermal conditions and the upper part of the zone of mixed effusion. In the paper a process is described in detail for obtaining fine apertures in extremely thin discs or membranes, and for measuring the areas of these openings. The membranes were obtained as follows: A solution of celluloid was made in equal parts of absolute alcohol and ether. Of this solution 0·4 c.c. was placed in a ring of iron floating on a mercury surface. After evaporation of the solvent a membrane is left in the ring. The holes were made by subjecting the films to minute droplets of sulphuric acid obtained by forming a mist in a tower and allowing it to deposit on the film and then heating carefully. E. G.

1358. *Properties of Gases in High and Low Vacua.* (Engineering, 117. p. 330, March 14; 365–366, March 21; 387, March 28, and p. 429, April 4, 1924. Lectures delivered before the Roy. Inst.)—In the first of the course of lectures delivered by **Sir E. Rutherford,** the history is given of the production of vacua from the original experiments of Torricelli in 1643 and the invention of the air pumps by von Guericke up to and including the introduction of the Gaede molecular pump in 1912. The work of Geisler and of Sprengel, who invented the first mercury pumps, and Dewar's discovery of the fact that charcoal cooled by liquid air has an extraordinary power of absorbing gases, are mentioned. In the second lecture the Gaede diffusion pump which operates by the diffusion of the air to be exhausted into a very rapidly moving stream of mercury-vapour, and the pumps due to Langmuir and Kaye are described. This second paper is illustrated with sectional diagrams of the various pumps, and graphs showing speeds of working of the pumps. In the third lecture various gauges are described including the tilting mercury gauge of Rayleigh, the well-known MacLeod gauge, that due to Knudsen, the quartz fibre decrement gauge, and the Pirani gauge. Diagrams of the Knudsen and quartz fibre gauges are given. In the last lecture the moleculer gauge of S. Dushman, which is reliable down to pressures of 10^{-5} cm., is described. Below 10^{-6} cm. the oscillations of this instrument become troublesome, as there is no damping. Pressures can also be measured by means of thermionic valves. If the gas within the valve were at a reasonable pressure, the electrons sent by the filament over to the grid would collide with gas molecules and produce positive ions proportional in number to the number of the residual gas molecules. Other points dealt with are evacuation by means of charcoal and the difficulty experienced in these experiments due to the gradual liberation of gas and moisture from the walls and material of the apparatus. A diagram of Dushman's molecular gauge is given, as are also curves indicating the liberation of gas, chiefly water-vapour, at temps. ranging from 100° C. to 600° C. A. E. G.

1359. *Electrical Method for the Determination of Velocities of Detonation.* **J. E. P. Wagstaff.** (Roy. Soc., Proc. 105. pp. 282–298, March 1, 1924.)—A method is described for the measurement of time intervals of the order of 3×10^{-5} secs. This depends on measuring the residual charge in a condenser initially charged to a known potential, when it has been allowed to discharge through a resistance for the time to be measured. The theory is checked by measuring by this means the time of contact of rebounding steel balls and the agreement with theory is good. Application to the measurement of velocity of detonation is made by having two fine wires passing through a column of explosive. The first is in series with a battery which charges the condenser initially, the second in series with a resistance across the condenser. The resistance is of such a magnitude as to make the decay viscous. After firing, the condenser is discharged through a ballistic galvanometer. Errors are introduced by conduction through the explosion gases, by lag in the breaking of the wires, by thermo-electric effects, and by leakage, but can be eliminated. Very consistent results are obtained using lengths of explosion as low as 15 cm. A. Wh.

1360. *The Transmission of Detonation at a Distance.* **E. Audibert.** (Colliery Guardian, 127. p. 153, Jan. 18, 1924. From Annales des Mines.) —In order to determine the aptitude of an explosive for transmitting detonation through an air-filled space, the following method is used at the Montluçon Experimental Station. Two cartridges, separated by a free space of length d, are inserted in a shot-hole bored in a block of clay. Two distances d_0 and d_1 are then determined, such that detonation is always transmitted from the first cartridge to the second when $d < d_0$, but never occurs when $d > d_1$. These experiments have been continued, both in the open air and as above in a shot-hole. The study of the factors influencing the transmission of detonation, besides its theoretical interest, may also afford valuable information on the precautions to be adopted in blasting coal. The factors in question include the diameter and density of the cartridges, the chemical composition of the cartridge (especially the moisture content), the physical condition of the charge, the weight of the detonated cartridge, and the nature of the detonator. The conclusions drawn from a number of tests are, that whether the tests are carried out in the open or in a shot-hole, there exists for every explosive of definite composition and well-defined physical condition a limit distance of transmission of detonation. Irregular results are due either to defective apparatus, or to slight variations in the composition or physical condition of the explosive examined. Stress is laid on the importance of prevention of absorption of moisture during storage. T. B.

1361. *Accuracy and Sensitivity of a Pressure Gauge of the Amagat Cylinder Type.* **A. Michels.** (Ann. d. Physik, 73. 7–8. pp. 577–623, March, 1924.)—The pressure in this type of gauge is applied and measured by loading a piston which fits accurately into an outer cylinder containing oil. This oil transmits the pressure, which can be calculated in the usual way from a knowledge of the load and the area of the piston. The particular instrument under test here is one based on the design of Schäffer and Budenburg. It goes up to 250 atmospheres. The first part of the paper deals with the sensitivity and constancy of zero at different pressures. The gauge is connected to a hydrogen manometer (Cailletet tube) through the glass walls of which are sealed at intervals 5 platinum contacts. When the mercury in the manometer reaches one of these an attached galvanometer gives a kick. Thus each contact corresponds to a perfectly definite pressure in the manometer and therefore in the gauge also. By slightly varying the load on the piston whilst the mercury is in the neighbourhood of one of the contacts, it is possible to determine very accurately the sensitivity and to check the zero. For five different pressures ranging up to 250 atmospheres the sensitivity was found to be 1/120,000 and the zero constant to a higher degree.

The effective cross-section of the piston was found as follows. The gauge was loaded to, say, 200 atmospheres, and then a further load of 10 atmospheres (about) added. By a special device the exact amount of this extra load could be registered on a mercury manometer. Knowing the weights added to the piston to produce this increment, the effective area is easily calculated. It is concluded that this area is the mean between that of the piston and that of the containing cylinder. Then follows a discussion (partly mathematical) of several other points. The effect of friction between the piston and cylinder, the effect of viscosity of the oil, the correction to be made because of the sinking in of the piston into the cylinder, effects of distortion due to pressure, etc. Numerical values are found for these corrections, which are in all cases small, and it is concluded that a gauge of this type can give results exact to about 1 in 20,000. A. A. D.

1362. *Automatic Pressure Regulator.* **L. E. Dawson.** (Indust. and Engin. Chem. 16. pp. 160–161, Feb., 1924.)—This regulator consists essentially of a form of trap or baffle connected by means of two vertical tubes of different diameters and lengths with a reservoir of mercury open to the atmosphere. The action depends upon the passage of a certain quantity of air through the tubes of smaller diameter when enough mercury in the reservoir to uncover the lower end of the smaller tube has been forced through both tubes into the trap. Further passage of air is stopped when the mercury in the reservoir rises by returning through the larger tube and closes the end of the smaller tube. The trap may be made from a test tube with an L-shaped side tube sealed in about 3 cm. from the closed end of the test tube, with the long arm turned facing away from the open end of the test tube, and on this is sealed a small tube to connect the regulator to the system which is to be kept at constant pressure. The open end of the tube is closed with a cork into which two glass tubes, one of which is much smaller in diameter than the other, are fitted, the free ends dipping into a mercury reservoir so attached to a separatory funnel that the height of the mercury in the reservoir can be adjusted. The end of the smaller glass tube is flared where it dips into the reservoir, so as to ensure greater sensibility. The regulator is connected to a suction flask. As described, the apparatus is for pressures less than atmospheric. With systems under pressures greater than atmospheric, slight modifications have to be made. T. C. H.

1363. *The Preparation of Membranes with Uniform Distribution of Pores.* **F. E. Bartell** and **M. van Loo.** (J. Phys. Chem. 28. pp. 161–165, Feb., 1924.)—Membranes having different degrees of permeability and the same number of pores per unit area of membrane may be prepared by the method devised by Bartell and Carpenter [see Abstract 2006 (1923)]. The authors find that as the result of vortex action during drying, such collodion membranes have a cellular structure. Membranes prepared from the same medium have the same number of cells per unit area, and hence, assuming that the pores in the membranes are the centres of these cells, have necessarily the same number of pores per unit area. The permeability of the membrane, which is largely dependent on the diameter of the pores, may be varied by arresting the vortex action at different stages by removal of the volatile constituent of the collodion.

J. S. G. T.

1364. *The Elasticity of Jellies Submitted to Electric Deformations. The Mechanism of Muscular Contraction.* **F. Michaud.** (Comptes Rendus,

178. pp. 993–994, March 17, 1924.)—Certain jellies traversed by an electric current contract at the anode and swell at the kathode [Abstract 1698 (1923)]. The present paper deals with the behaviour of the jelly after the current ceases. The effects are complicated, for in some cases the recovery to the original shape is almost immediate whilst in others it occupies several hours. Thin layers recover the more quickly and recovery can also be hastened if the jelly is prevented from contracting transversely in certain regions. This last effect throws light on the mechanism of muscular contraction. A. A. D.

1365. *Tables of Values of the Integral* $\int_0^x K_0(t)dt$. **S. P. Owen.** (Phil. Mag. 47. p. 736, April, 1924.)

1366. *Plasticity and Elasticity.* **E. C. Bingham.** (Frank. Inst., J. 197. pp. 99–115, Jan., 1924.)—The author discusses the phenomenon of plastic flow in its relation to elasticity in the light of recent researches. S. L. S.

1367. *The Viscous Flow of Plastic Material at Low Velocities.* **B. Marzetti.** (Accad. Lincei, Atti, 32. ii. pp. 399–402, Dec. 2, 1923.)—The rate of efflux of plastic rubber from small nozzles is studied and the results tabulated. From three series of determinations with different conditions it is concluded that the quantity of material Q expelled in time t by an applied force F will be given by $Q/t = K(F - f)$, where K and f are constants. A. Wh.

1368. *Volume Change of Metals during Solidification.* **H. Endo.** (Inst. of Metals, J. 30. 2. pp. 121–137 ; Corres., 137–138, 1923.)—Gives details of the measurement of the change of volume during solidification or melting for a number of metals having melting-points up to 1100° C. The method used consists in the measurement of the change of buoyancy of the metal suspended in an inactive liquid during its solidification or melting by means of a thermobalance, which is described and illustrated. The results obtained are as follows : Hg 3·75, Na 2·53, K 2·81, Sn 2·80, Bi − 3·32, Th 3·23, Cd 4·74, Pb 3·44, Cu 4·05, Al 6·26 per cent. These figures are in fairly close agreement with previously reported results, and the following new determinations are also given : Rb 2·57, Au 5·17, Ag 5·00 per cent. In the *correspondence* **T. Turner** points out that when metals are cast in sand-moulds there is usually an expansion noted immediately after solidification begins, and that although the metal itself does not expand, the casting does. C. O. B.

1369. *Elastic Distortions.* **I. Terni.** (N. Cimento, 26. pp. 147–156, Oct.–Nov.–Dec., 1923.)—Discussion of the question whether when displacements are rigid at the bounding surface, the parameters of dilatation and their derivatives are finite and continuous point-functions at all points and at the bounding surface, and whether the increments of the second and third derivatives of the components of displacement are null at the bounding surface, whence would follow that the increments of the first and second derivatives of the dilatation-parameters are also null over the surface. Conclusion in the affirmative. A. D.

1370. *Development of a Frequency Function and some Comments on Curve Fitting.* **E. B. Wilson.** (Nat. Acad. Sci., Proc. 10. pp. 79–84, Feb., 1924.)—The relative utility of various methods of expansion for the development of a function for theoretical or practical statistical purposes is discussed, and a variation of the general theorem of Fisher, based upon the Gaussian or normal frequency function is set forth, and its merits and demerits examined. The case of the number of petals in Ranunculus is chosen as an example, and the results obtained according to various methods graphically and tabularly compared. A. B. C. L.

1371. *Difference-Periodogram for Rapid Determinations of Short Periodicities.* **C. E. P. Brooks.** (Roy. Soc., Proc. 105. pp. 346–359, March 1, 1924.)—This method is useful in the preliminary exploration of long meteorological records of periodic or quasi-periodic components. In order to bring out the influence of the particular periodicity under investigation in a long series of observations, and to eliminate the effects of longer periodicities or of secular variation, the following operations are performed. (1) Divide the series into a number of equal sections, a, b, c, d, e, etc., each slightly greater or slightly less than half the length of the period. (2) Obtain the mean value of each of these sections. (3) Form the differences $(a-b)$, $-(b-c)$, $(c-d)$, $-(d-e)$, etc. (4) Form the mean of successive differences so that we have: $\frac{1}{2}\{(a-b)-(b-c)\}$, $\frac{1}{2}\{-(b-c)+(c-d)\}$, $\frac{1}{2}\{(c-d)-(d-e)\}$. (5) Plot the figures obtained in (4) with a horizontal time scale. It is shown how from this curve the details of the periodicity may be obtained. As examples, the method is applied to the analysis of rainfall records and temperature observations. The details of the periodicities found agree fairly well with those obtained by the more accurate but more laborious method of harmonic analysis. A. A. D.

1372. *Wave-Motion Models having "Dispersion" and "Filter" Properties.* **T. B. Brown.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 343–351, Feb., 1924.)—The mechanical models considered here consist of (*a*) systems of simple pendulums, the bobs of which are connected by springs, (*b*) an endless cord running over a series of fixed and movable pulleys of negligible mass, the movable pulleys supporting the coupling masses. Each case has its electric analogue. The transmission of waves along such systems is considered (for the steady state) as the forcing frequency is varied. Diagrams are given to show the range of waves which each system will pass or stop. All the models have "dispersion" properties, and one in particular illustrates very well the idea of anomalous dispersion. It is suggested that the models might prove useful in the experimental study of the transient phenomena leading up to the steady state. The work in the present paper is purely theoretical. [See also Abstract 1008 (1922).] A. A. D.

1373. *The Terminal Velocity of Particles of Powdered Coal Falling in Air or other Viscous Fluid.* **J. Blizard.** (Frank. Inst., J. 197. pp. 199–207, Feb., 1924.)—From dimensional considerations, and the results of a series of experiments by E. Audibert, the formula for the terminal velocity, U(cm./sec.) is:

$$U = \frac{a^{0 \cdot 9}}{3 \cdot 4\nu^{0 \cdot 27}} \left(\frac{D}{d}\right)^{0 \cdot 44}$$

where a is the diameter of the particle, in microns; ν the kinematic viscosity of the fluid (c.g.s.); D the density of the particle (c.g.s.); and d the density of the fluid (air = 1). It is shown that the effect of temperature is practically negligible, and that the particle attains its terminal velocity after a fall of a few inches only, under conditions occurring in practice. W. G. B.

1374. *Experiments on Copper Wire.* **D. H. Ingall.** (Inst. of Metals, J. 30. 2. pp. 171–188; Disc., 188–196, 1923.)—The author gives the results of a number of experiments in which annealed copper wire and the same wire after reductions of cross-sectional area of 25, 40, 50, and 75 % by drawing, were tested under constant load at a varying temperature, in order to obtain the temperature at which the wires broke under a given load. The temperature-load curves obtained show an inflection at about 350° C. and the straight-line portion of the curve up to this temperature conforms to the ordinary algebraical equation $y = a + bx$ where y is the tensile strength, x the temperature, and a and b are constants. The value of the constant a indicates a relative measure of the susceptibility of the material to hardening or strengthening by cold work and constant b the susceptibility to softening or annealing with rise of temperature. The relationship between the increase in value of b and the reduction of area by drawing indicates that the tensile strength of the copper used is a linear function of both temperature and amount of cold work. The portion of the curve beyond 350° C. corresponds to the equation $xy^n = k$, where n and k are constants and either x or y may be cohesion or temperature as the case may be, and it is found that in this range, the tensile strength of the copper used is a function of both temperature and cold work up to 50 % reduction. Up to the critical temperature 350° C. the fracture took place across both grains and grain boundaries and above 350° there was an indication that fracture took place along the boundaries only.

C. O. B.

1375. *The Constitution of Solids.* **C. E. Mendenhall.** (Science, 59. pp. 219–230, March 7, 1924. Address delivered to the Am. Phys. Soc., Dec., 1923.)—An outline of recent work on the properties and constitution of solid bodies. Recent results of X-ray analysis of crystals are discussed and emphasis laid on Shearer's theory of molecular symmetry. A renewed interest in the dynamical theory of crystal lattices is noted, and important phenomena of phosphorescence and fluorescence are described as well as Darwin's quantum theory of refraction and dispersion. The properties of metallic solids have been elucidated by Bridgeman's work on the variation of electrical properties at high pressures, and other developments mentioned include Whittaker's proposed mechanism to account for the interchange of energy by quanta between an atom and an electron.

A. Wh.

1376. *On the Energy Components in Hilbert's Theory of Matter.* **A. Bikowski.** (Zeits. f. Physik, 21. 5. pp. 299–303, 1924.)—In his work on the differential laws for the conservation of impulse and energy in the Einstein gravitation theory, Klein, by employing the classical methods of the calculus of variations, has given a clear interpretation to the Hilbert theories. The present author now seeks to extend the Klein considerations. Using the latter's nomenclature, the infinitesimal transformation of the world parameter $w^\tau (\tau = 1, 2, 3, 4)$, $\delta w^\tau = p^\tau$, is applied to the quadruple integral $T_2 = \iiiint L\,dw$, where dw is the invariant space element, $dw = \sqrt{g}\, dw' \ldots dw^4 = ds$, and L is the electrical component of the world function. A series of differential relations then arise which are satisfied identically by L. By their aid the so-called energy components of the electromagnetic field can be defined. The expression obtained does not admit, however, of a physical interpretation, but its validity is established for cases in the special theory of relativity. H. H. Ho.

1377. *The Nucleus of the Atom.* (Engineering, 117. pp. 458–459, April 11, 1924. Discourse before the Roy. Inst.)—This is an account of a discourse by **Sir E. Rutherford,** describing the present state of the theory of the atomic nucleus, and in particular the deduction of the minuteness of the nucleus from the scattering of α-particles when they pass through matter. Experiments are described to illustrate the scattering at all angles, including nearly 180°, a head-on collision, and also the difference between swift and slow particles. The experiments of Chadwick and E. S. Bieler with lighter atoms, where the α-particle may be expected to approach closer to the nucleus than in the case of heavy atoms, are dealt with; the inverse square law no longer holds at closest approach. Bieler found that with aluminium the repulsive and attractive forces seem to balance at 4×10^{-13} cm. The work of J. Chadwick and C. D. Ellis on the β-ray spectra of RaB and RaC is noticed and the determination by Ellis of the wave-lengths of the γ-rays from the nucleus, which falling on the satellite electrons produce the β-radiation; energy levels in the nucleus have been determined, changes between which produce these γ-rays, and these levels are very similar for RaB and RaC; but the former are displaced in the direction of less energy. Protons have been ejected by the lecturer by bombarding with α-particles Ne, Mg, Si, S, Cl, Ar, and K, in addition to the original six "active" elements; H, He, Li, C, and O gave no effect, Be (metallic) gave a slight effect, which may be due to a contamination with fluorine; a number of heavy metals gave no effect. Possible directions of further research were indicated, and the lecturer concluded by remarking that much more progress had been made in solving the most fundamental problem of physics, that of the structure of the nucleus, than he had thought possible ten years ago. H. N. A.

1378. *A Spectroscopic Confirmation of Bohr's Distribution of Electrons in the Model of the Cæsium Atom.* **E. Fues.** (Zeits. f. Physik, 21. 5. pp. 265–280, 1924.)—The author has previously shown that it is possible, in the case of sodium I, to determine an atomic field which allows the spectral terms to be calculated with a small percentage of error, without considering in detail the mutual influence of the moving electrons on one another; it is also possible in a simple manner to study the relationship between the spectra NaI, MgII and AlIII. The full value of the method, and particularly its applicability to the X-ray terms, could only be tested on an atom with complicated electronic structure, and the cæsium arc spectrum has therefore been investigated in the present paper; the formulæ have been extended to include relativity effects the influence of which, as seen in the relativity X-ray doublets, is here very great. It is shown that the only universal constants that enter into the calculation are Rydberg's number and Sommerfeld's fine structure constant; and the connection between the potential found and the increase of nuclear screening is worked out, so that practical calculations can be made. An atomic field is found in which orbits exist which agree with the terms of the cæsium spectrum from the point of view of energy, and also with the quantum rules (the calculated quantum numbers k and n' are very nearly whole numbers). It turns out indeed that the method is particularly convincing in the case of this complicated atom. The arc spectrum of magnesium is also dealt with, as in this case a strong mutual action of the two outer electrons was to be expected. The paper concludes by showing how the calculated central fields can be explained by means of models, without any definite representation of the mutual play of the electrons. The author's statical "*Ersatz*" model is built up on the assumption that the spectroscopic calculation of the field can give an insight into the true dimensions of the electronic layers, and, using Bohr's electron distribution, into those of the separate groups of orbits, with the same degree of accuracy with which it represents the spectral terms. From this model, using certain very probable assumptions as to the distribution of the electrons, a second field distribution can be calculated, which is in fact in very good agreement with the first, which was obtained without the help of a model from purely spectroscopic considerations. H. N. A.

1379. *Inner Quantum Numbers for Neutral Helium.* **A. E. Ruark, P. D. Foote,** and **F. L. Mohler.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 17–19, Jan., 1924.)—The narrow doublets of helium owe their origin to a double p term, and in this case the $2p_1$ level has a greater wave number than the $2p_2$. Analogy with the alkalies makes it probable that the composite doublets of the helium diffuse series will be found to consist of three members. Lohmann has detected a satellite with a wave-length slightly greater than D_3, though the observation needs confirmation, using crossed echelons. Assuming this line not to be a ghost, inner quantum numbers are allocated. They are $2p_1-3d_1$, $2p_2-3d_2$, $2p_1-3d_2$ in order of decreasing intensity. Usually the first and last are not resolved owing to the closeness of the d terms. $2p_2-3d_1$ is ruled out by the selection principle. Inverse p levels are not known in other doublet spectra. Energy diagrams are given for this case and for cases where d is inverse, and both p and d are inverse. The inner quantum number j for the s states may be 1 or 2, the evidence is insufficient to discriminate between them. A. Wh.

1380. *The Simultaneous Action on the Hydrogen Atom of Intersecting Homogeneous Electric and Magnetic Fields.* **O. Klein.** (Zeits. f. Physik, 22. 1–2. pp. 109–118, 1924.)—The question of the simultaneous action on the H atom of a homogeneous electric and a homogeneous magnetic field whose directions form any angle with each other has been discussed from many sides. Whilst each field by itself (neglecting the small divergences from the laws of ordinary mechanics given by the theory of relativity) produces to a first approximation purely periodic secular disturbances in the motion of the electron, the corresponding motion appears to be of more complicated nature with the existence of both fields. It was almost suspected that these disturbances possess a completely unperiodic character, which according to the principles of the quantum theory would have for consequence that no well-defined stationary state could exist. Epstein by the method of calculation of perturbations has shown the disturbances in question to be of complex periodic character. Halpern reaches the same result, and exhibits the solution of the problem as an endless series whose convergence he maintains. The author shows that the solution of the problem can be obtained in the concluding form given by Epstein in a very simple way whereby the character of the motion is at the same time manifested. The method used corresponds to that employed by Bohr for the calculation of the Stark effect, and which enabled this phenomenon to be explained in a specially simple and clear way. The paper contains the mathematical calculation of the secular disturbances, and the resulting determination of the stationary state in the case of the system in question. Later the author intends to publish some observations upon the behaviour of the system with adiabatic changes of the external fields, upon the intensity and polarisation of the spectral lines affected, together with the treatment of some further cases by means of a similar method. J. J. S.

1381. *The Theory of Helium.* **F. J. v. Wisniewski.** (Phys. Zeits. 25. pp. 135–137, March 15, 1924.)—Of the investigations published recently by Landé, Tank, and Born and Heisenberg on the helium atom, only negative results are mainly recorded, which has led to the opinion that the principles of classical mechanics are insufficient for the determination of the electronic movements. The present author now treats the problem by a somewhat different method to that employed by the above authors, and shows that certain corrections of the terms agree very well with those determined for parhelium and especially so with the *d*-terms. The problem is reduced by him to the solution of that of three bodies, and is accomplished for this special case by the assumption that the nucleus is at rest and that the first electron moves in a circular orbit with constant angular velocity. The three-body problem is then simplified to that of the motion of the second electron. The paper is entirely mathematical. H. H. Ho.

1382. *Distribution of Electrons in the L Levels of Atoms.* **A. Dauvillier.** (Comptes Rendus, 178. pp. 476–479, Jan. 28, 1924.)—De Broglie has shown that a knowledge of the relation intensities of the absorption bands due to the electrons in an atom allows the relation numbers of these to be calculated. The L absorbtion of gold is investigated. A photometric method employing a continuous spectrum which is photographed through the substance and through an echelon wedge of aluminium is used. This method is not precise enough for measurements on intense lines, and in this case direct measurement with an X-ray spectrometer is employed. This gives values which lead to the equations: $n_1/n_3 = 0{\cdot}495 \doteq 0{\cdot}5$, $n_1/n_2 = 0{\cdot}78 \doteq 1{\cdot}0$. Then $n_1 + n_2 + n_3 = 8$ and hence $n_1 = n_2 = 2$, $n_3 = 4$. The distribution thus appears to be $2L_1$, $2L_2$, and $4L_3$. A. Wh.

1383. *The Calculation of Electrostatic Potentials and of the Energies of the Dipole and Quadrupole Lattices.* **H. Kornfeld.** (Zeits. f. Physik, 22. 1–2. pp. 27–43, 1924.)—This paper is an extract from the author's Göttingen dissertation (1923) on the union of the particles in lattices of different dipole and quadrupole gases. Reference is first made to recent work by Born and the author [see Abstract 1749 (1923)] on the success which has attended their evaluation of the heats of sublimation of the hydrogen halides from dimensional considerations. Following this comes the derivation of general formulæ for the calculation of electrostatic potentials and energies of any given dipole and quadrupole lattices. These formulæ are then applied to the evaluation of the energies of two particular regular lattices. H. H. Ho.

1384. *The Electrostatic Nature of the Molecular Field.* **P. Weiss.** (Comptes Rendus, 178. pp. 739-742, Feb. 25, 1924.)—Ferro-magnetic magnetisation can be represented by adding the external field and a molecular field proportional to the intensity of magnetisation. If H_m be the molecular field, then $H_m = NI$. Lorentz has given a formula, $N = 4\pi/3$, for dielectrics on the assumption that the molecular field is the result of the mutual magnetic moments of the molecules. Experimentally N is about 3000 times as great, and it seems impossible that the molecular field can be produced by the elementary magnets. It is suggested that the molecules combine both magnetic and electrostatic bipoles in similar directions, and that the latter are responsible for the orientation of the molecules. An expression for the moment ϵ of a dipole is derived; $\epsilon^2 = \frac{9R\theta M}{4\pi d}$, where R is the gas content, θ the Curie point, M the molecular weight, and d the density. The order of the moment thus calculated agrees well with those calculated from Debye's theory of dielectrics. A. Wh.

1385. *Quantum Assignment for Arc Spectra according to Bohr's Theory.* **F. S. Brackett** and **R. T. Birge.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 213–230, Feb., 1924.)—An assignment of quantum numbers to various atomic states is carried out by considering a progression from simple to more complex atoms. In the cases of hydrogen and ionised helium, the problem can be treated directly. In the case of an excited neutral atom, the orbit of the displaced electron will lie wholly without and remote from the nuclear charge $+ Z$ and an electronic charge $-(Z-1)$; hence its kinetic energy for such an orbit will be the same as for the same orbit round a hydrogen nucleus, and a quantum assignment may be made. If the orbit is not wholly unaffected by the other electrons, the idea of "quantum defect" is introduced and defined by q where $v = R/(n - q)^2$. Here R is the Rydberg constant, n is the total quantum number of the orbit, and v is the wave number of the orbit. Diagrams are given showing the "denominator," $n - q$, plotted against the number of orbital groups in the atom body, and remarkable regularities and parallelisms are noted and claimed as corroboration of the quantum assignments used. By the aid of these diagrams a wide correlation of spectroscopic and X-ray is possible. In general the assignments used agree with those given by Bohr, but a few are altered while several new ones can be made. A. Wh.

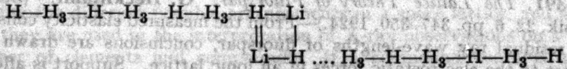
1386. *Evaluation of Quantum Integrals.* **J. H. van Vleck.** (Phys. Rev. 22. pp. 547–558, Dec., 1923.)—I. *Choice of Coordinates.*—In a dynamical system with n degrees of freedom, kinetic energy T, and potential energy V, the Sommerfeld-Wilson quantum conditions require that $\Sigma p_i dq_i = \Sigma n_i h$ $(n = 1, 2, \ldots n)$, where the n_i are integers, and each integration is to extend over a complete cycle of values for q_i. It is usually stated that the q_i are a set of generalised coordinates satisfying the Lagrange equations $d \mid dt(\partial L \mid \partial \dot{q}_i)\, \partial L \mid \partial \dot{q}_i = 0$ . . . (1), where $L = T - V$ and the p_i are the corresponding momenta defined by the relations $p_i = \partial T/\partial \dot{q}_i$ . . . (2).

Consequently, $dq_i \mid dt = \partial \mathrm{H} \mid \partial p_i$, $\partial p_i \mid dt = - \partial \mathrm{H} \mid \partial q_i$ . . . (3), where H is the Hamiltonian function or energy. Now unless p_i can be expressed in the form $p_i = f(q_i)$ . . . (4), it is usually impossible to determine the cycle over which the integration should extend, so that the quantum integrals lose all meaning. The choice of appropriate coordinates is therefore of fundamental importance. Unfortunately in many problems, coordinates satisfying all four conditions are not obtainable, and resort is necessary to those satisfying (3) and (4), but not necessarily (1) and (2). The author obtains a general criterion for the choice of such coordinates. It is shown that all sets of p_i and q_i which (*a*) satisfy Hamilton's equations, (*b*) separate the variables, and (*c*) are of such a character that the average value of the kinetic energy is equal to that of $\Sigma p_i \dot{q}/2$, will give the correct energy levels when employed in the quantum integrals defined above. This general class of coordinate systems includes as special cases the normalised Schwarzschild angle variables and Lagrangian generalised coordinates which separate the variables.

II. *An Extension of Trkal's Variation Principle.*—The author here proposes a combination of Hamilton's principle with Trkal's method of quantising conditionally periodic systems which, like the former, determines the character of the motion permitted by the Newtonian dynamics, and in addition quantises the orbits by specialising the constants of integration in accordance with the conventional quantum conditions. This variation principle includes formally in a single equation the results of classical dynamics and the Sommerfeld quantum conditions, which together determine the sizes and shapes of electronic orbits. The principle is illustrated by application to a non-linear oscillator in which the potential involves the second and fourth powers of the displacement from the equilibrium position. G. W. DE T.

1387. *On the Quantum Theory of Molecules.* **M. Born** and **W. Heisenberg.** (Ann. d. Physik, 74. 1. pp. 1–31, April, 1924.)—The paper commences with a brief account of the various stages of the evolution of the quantum theory as applied to molecules. [See Abstracts 1527 (1923) and 86 (1924).] The authors then consider a molecule as a mechanical system of nuclei and electrons in dynamical equilibrium, and systematically develop the theory of band spectra. The mathematical treatment of the problem depends on the fact that the energy function is expanded in powers of λ, where λ^2 is of the dimensions of the ratio electronic mass/nuclear mass. Such solutions of the dynamic problem have been sought by which the nuclei move from the equilibrium position only by the amount of the dimensional order λ. It is assumed from the equilibrium position of the nuclei that all do not lie in a straight line, and that all impulses and rotatory impulses remain finite for $\lambda = 0$. For mathematical formulation a moving system of coordinates is introduced in which the equilibrium position of the nuclei is static, and the various equations are then derived. From the Hamiltonian function of this problem the Lagrangian factors corresponding to the secondary conditions are eliminated and the mechanical problem can then be treated by the methods of the disturbance theory. The disturbance function of the first order has a vanishing average value in consequence of the demand that equilibrium positions of the nuclei should exist. The disturbance function of the second order determines the nuclear oscillations and gyratory movements as secular disturbances. The separation of the variables for the oscillations is attained by the introduction of normal coordinates. The disturbance function of the third order affords no contribution to the energy, and that of the fourth order depends in very complex fashion on the electronic movement and rotation. The case of nuclei in equilibrium in a straight line leads to degeneration. The paper is mathematical throughout. H. H. Ho.

1388. *The Structure of Neon and Argon.* **H. Collins.** (Chem. News, 128. pp. 81–83, Feb. 8, 1924.)—The atomic weights of the dominant isotopes of some of the lighter elements are considered, and it is concluded that neon 20 is built up of $Li + H + H_3 + H + H_3 + H + H_3 + H$, though apparently $H + H_3$ is regarded as identical with helium; argon 40 may either be $Na + H + Li + H + H_3 + H + H_3 + H$, or, as the author thinks is more probable,



$$\begin{array}{ccccccccccccccccccccccccccc}
\mathrm{H}&-&\mathrm{H_3}&-&\mathrm{H}&-&\mathrm{H_3}&-&\mathrm{H}&-&\mathrm{H_3}&-&\mathrm{H}&-&\mathrm{Li}&&&&&&&&&&&&\\
&&&&&&&&&&&&\|&&|&&&&&&&&&&&&\\
&&&&&&&&&&&&\mathrm{Li}&-&\mathrm{H}&\ldots&\mathrm{H_3}&-&\mathrm{H}&-&\mathrm{H_3}&-&\mathrm{H}&-&\mathrm{H_3}&-&\mathrm{H}
\end{array}$$

Valency is treated, the author apparently not considering the Lewis-Langmuir or the Bohr models capable of explaining this. H. N. A.

1389. *Scattering of Particles by an Einstein Centre.* **W. S. Kimball.** (Phys. Rev. 23. pp. 75–84, Jan., 1924.)—The object of this paper is to consider the scattering of a stream of particles when the Coulomb inverse square law of force is replaced by Einstein's law corresponding to a fixed point centre. Rutherford and Darwin [see Abstract 1302 (1914)] have developed formulæ based upon the inverse square law, which account for the scattering of α-particles and hydrogen atoms to a high degree of accuracy. Lunn's work is noticed incidentally. The present author now employs the Schwarzschild solution of the field equations of gravitation taking the constant of integration which measures the strength of the centre as purely electrical in nature and equal to NeE/c^2M instead of $\gamma m/c^2$, the Einstein centre being thus used to account for Coulomb's instead of Newton's law as in the relativity theory of gravitation. No attempt is made to combine gravitational and electrical terms in the potentials such as are developed by Jeffery and Nordström. The resulting formula agrees with Rutherford's except that there are added to the factor $\cot^2 \phi/2$, ϕ being the angle of deflection, terms in V^2, V^4, etc., where V is the velocity of the ray divided by that of light. The result is that the scattering is no longer accurately proportional to $1/V^4$ nor to $\cot^2 \phi/2$. However, for values of V from 1 to 2×10^9 cm./sec., the departures are less than 1 %, *i.e.* less than the probable error of the experimental results; but an accuracy of 1/1000 would decide between the two theories. So far as the scattering of α-particles by gold and other metals is concerned, the facts are accounted for equally well by either the relativity or the classical theory. H. H. Ho.

1390. *Coefficients of Slip and Momentum Transfer in Hydrogen, Helium, Air, and Oxygen.* **E. Blankenstein.** (Phys. Rev. 22. pp. 582–589, Dec., 1923.)—In the experimental determination of the coefficients of slip for polished silver oxide surfaces in spectroscopically pure hydrogen, helium, air, and oxygen, the rotating cylinder method is employed, a continuous circulation of gas being maintained to minimise the effect of the release of occluded gas from the walls of the apparatus. The mean values obtained, reduced to 23° C. and 760 mm. Hg pressure are, for H_2, 121×10^{-7}; for He, 190×10^{-7}; for air, $68 \cdot 5 \times 10^{-7}$; and for O_2, $72 \cdot 1 \times 10^{-7}$; these are accurate to about 1 %, the respective values for Maxwell's coefficient of diffuse reflection being 1·00, 1·00, 0·98, and 0·99. These results, which are in good agreement with the values computed from kinetic theory, are checked by measurements of the variation of the deflection with pressure at low pressures from 0·0003 mm. to 0·0015 mm., where the mean free path is considerably greater than the distance between the cylinders. It is concluded that for these gases practically all molecules are diffusely reflected from the surfaces used, the percentages specularly reflected being nearly zero for H_2 and He, and about 2 or 3 for air and O_2.

A. B. C. L.

1391. *The Lattice Theory of Fluorspar.* **G. Heckmann.** (Zeits. f. Physik, 22. 6. pp. 347–350, 1924.)—From the measured elasticity constants and residual ray wave-lengths of fluorspar, conclusions are drawn with respect to the electrostatic forces in an ionic lattice. Support is afforded to the Born conception of the repelling force as an electrostatic effect of the outer electronic shell taking into account the phase relations of the circulating electrons.

H. H. Ho.

1392. *Lattice Structure of White Tin.* **H. Mark** and **M. Polányi.** (Zeits. f. Physik, 22. 3. p. 200, 1924.)—A supplement to a previous paper [Abstract 356 (1924)] correcting a figure there given in which, through misdrawing, the position of the atoms in the lattice structure was not properly shown. Another figure is given showing the relationship between the tin lattice and the diamond lattice, and also the lattice of the titanium atoms in anatase. Other corrections are given, and everywhere in the text of the first paper [001] should be read instead of [100] as designation of the *c*-axis.

J. J. S.

1393. *The Lattice of Aluminium Nitride* (*AlN*). **H. Ott.** (Zeits. f. Physik, 22. 4. pp. 201–214, 1924.)—The author, partly in association with H. Grimm, is endeavouring to complete the investigation of the lattice structure of compounds of the type MX, and amongst these AlN is of particular interest, since it stands in the series of binary compounds NaF, MgO, AlN, SiC, in which the negative component stands as far below neon in the periodic table as the positive stands above that element. With NaF and MgO we have an ionic lattice, confirming Kossels' theory that the atoms gain or lose electrons so as to attain the configuration of the inert gases. On the other hand, the similarity of SiC to the diamond indicates that here the structure is not a polar one, and that the lattice is built up of atoms; the object of the investigation was to find out if possible, by means of X-ray measurements, whether AlN is built up of atoms like SiC, of ions Al^{+++} and N^{---}, or whether some intermediate structure exists between these two extremes; the difference between the number of electrons in the different components in the first two cases is large, and thus the difference in scattering effect will be great, so that a definite result may be expected. A Laue diagram showed that the crystals belong to the hexagonal system. The exact structure was determined by combining Schiebold rotation diagrams with Debye diagrams, using first copper and then molybdenum for the antikathode, so as to obtain X-rays of different wave-length. The Al and N atoms form two interpenetrating hexagonal lattices, with tightest spherical packing, and a small compression along the six-fold axis of the hexagonal prism; the base axis $a = 3 \cdot 113$ Å., and the axial ratio is $c = 1 \cdot 601$; the two lattices are shifted with respect to one another along the six-fold axis, the parameter p being $0 \cdot 38$. Each atom is surrounded by four atoms of the other element, in a slightly distorted tetrahedron, the distances being equal ($1 \cdot 894$ Å.). The combination is certainly not polar, the corners of the lattice being occupied by atoms with 7 and 13 electrons respectively; this follows from the relative intensities of the lines in the X-ray diagrams. H. N. A.

1394. *Results of X-Ray Examination of Crystal Structure.* **R. Gross.** (Zeits. Elektrochem. 30. pp. 1–5, Jan., 1924. Paper read before the Deut. Bunsen-Gesell., Hanover, May, 1923.)—The author reviews briefly the geometrical methods of A. Schoenfliess, Fedorow, Barlow, and Bravais, defining the different possible arrangements in a space lattice, and shows how they are used in the interpretation of X-ray observations on a large number of elements and compounds. If a compound contains atoms *a, b, c, d,* and each atom *a* in the crystal can only be assigned geometrically to one *b, c,* and *d,* the union is called molecular; while in an ionic union, as in NaCl, *a* is united not only to *b,* but also to other atoms of that element b_1, b_2, b_3; it is, of course, necessary, in the latter case, to prove that *a, b, c,* and *d* really carry electrical charges. The *abcd* atomic complex might itself act as an ion; in calcite, for example, CO_3 is united in closest packing, and the electrons are distributed so that the group CO_3 acts as a doubly charged ion. In other cases such a definite statement as to the electron distribution is not possible. In the zircon lattice (ZrO_2SiO_2) the two oxygen atoms are so closely arranged, with respect to the silicon atom, that we must speak of a molecular lattice; the ZrO_2, however, is arranged in quite a different manner in the lattice, the O atoms are so close together that one can assume an O_2 group, which is joined to the surrounding Zr atoms by four valency bonds; and the lattice is built up of SiO_2 molecules, and the ions of ZrO_2. The crystals are isomorphous with those of TiO_2. To the question, why do the atoms of different substances arrange themselves in different lattices, in which the packing is much less than close packing, the only answer is that there are directed valency bonds, which determine the structural plan of the lattice. The author considers that, for further advance, either more accurate measurements of intensity in the X-ray measurements will be needed, or measurements of the vectorial combining forces of crystals by means of experiments on cohesion will be necessary. H. N. A.

1395. *The Hodograph of Newtonian Hyperbolic Reflection.* **C. Barus.** (Science, 59. p. 260, March 14, 1924.)—Apropos of Lodge's recent treatment [Abstract 1074 (1924)] of the reflection of atomic nuclei, a graphic exhibit of the hodograph of such cases is now given and contains many interesting features. The figure gives the twin hyperbolas with their common axis and asymptotes, one corresponding to repulsion and the other to attraction. H. H. Ho.

1396. *Michelson's Experiment.* **A. Metz.** (Comptes Rendus, 178. pp. 314–316, Jan. 14, 1924.)—Combats Brylinski's methods, in which the author says Brylinski has applied a contraction, but has neglected the effect of the contraction upon the 45°-mirror itself. If this be taken into account, the Lorentz contraction is restored. A. D.

1397. *Michelson's Experiment.* **E. Brylinski.** (Comptes Rendus, 178. pp. 466–467, Jan. 28, 1924.)—Note in reply to Metz [see preceding Abstract] pointing out that it is usual to assume the semitranslucent mirror to stand at 45° without reference to Lorentz contractions, and emphasising the importance of the positive results obtained by Miller in 1921 (Phys. Rev. 19. No. 4. 1922). [See also Abstract 430 (1924).] A. D.

1398. *Michelson's Experiment, Lorentz's Contraction and Relativity.* **E. Brylinski.** (Rev. Gén. d'Él. 15. pp. 243–250, Feb. 16; 283–288, Feb. 23, and pp. 339–347, March 1, 1924.)—The author gives calculations. The Lorentz contraction corresponds only to a particular case of adjustment of apparatus, and is incompatible with positive results being obtained in both positions. [See preceding abstracts.] A. D.

1399. *On the Possibility of a World with Constant Negative Curvature of Space.* **A. Friedmann.** (Zeits. f. Physik, 21. 5. pp. 326–332, 1924.)—In a previous paper [see Abstract 2215 (1922)] on the curvature of space, the author has considered those solutions of the Einstein world equations which lead to world types possessing a constant positive curvature, all possible cases having been discussed. The possibility of deriving such a world from the equations is bound up with the problem of the finite character of space, and the present investigation has been undertaken to ascertain whether a world of negative curvature can be derived from the equations whose finiteness can hardly be in question. It is shown to be really possible to derive the latter universe of constant negative space curvature from the Einstein equations. Two cases are distinguished, *viz.* (1) A stationary world whose time curvature is constant, and (2) a non-stationary world whose space curvature is constant but which varies with time. Between the stationary worlds of constant negative and positive spatial curvature an essential difference arises. The former permits of no positive density for matter, this being either nil or negative. The physically possible stationary worlds (*i.e.* those with a non-negative density) find analogy accordingly with the de Sitter, but not with the Einstein world. Finally the problem is discussed as to whether a decision can be made as to the finite or infinite character of space based on curvature considerations. Space with constant positive curvature is found to be finite, but the same arguments do not hold for the finiteness of space with constant negative curvature, so that Einstein's world equations do not allow a conclusion to be drawn as to the finite character of space without supplementary assumptions. H. H. Ho.

1400. *Courvoisier Effect and Einstein Effect.* **A. Kopff.** (Phys. Zeits. 25. pp. 95–96, Feb. 15, 1924.)—To complete the criticism of Kienle on "Cosmical Refraction" [Abstract 1107 (1924)] some considerations regarding the Courvoisier effect may be added, regarding it not as resulting from a cosmical cause but from a special method of observation. The Courvoisier effect has only been observed visually, and at distances greater than 3° from the sun; the eclipse plates cover a distance of from 3° to 0°·5 from the sun. At 3° Courvoisier finds a shift of somewhat uncertain amount, about 0″·5, but the shift on the plates, which may be relied on as accurate because of the precautions taken, is 0″·2. For smaller distances than 3° no observations of the Courvoisier effect have been made, and as no satisfactory physical interpretation of it has been discovered, extrapolation is not admissible. Hopmann, however [Abstract 803 (1924)], extrapolates both the Courvoisier effect and the eclipse measurements up to the sun's limb, and finds that they agree. It is possible that future observations may prove an agreement in amount, but as the matter now stands it can only be stated that the Courvoisier effect and the eclipse measurements both show a shift of stars radially outwards from the sun. Everything points to the probability that the Courvoisier effect is due to systematic errors in a special method of visual observation. On the other hand, the eclipse results agree, without extrapolation, and as well as can be expected from the difficulties of measurement, with the effect required by the theory of Einstein. M. A. E.

1401. *Cayleyan Distance and the Kinematic Space of the Restricted Theory of Relativity.* **A. H. S. Gillson.** (Roy. Soc. Canada, Trans. 17. Sect. 3. pp. 189–190, 1923.)—The hypothesis that the kinematic space of classical mechanics is Euclidean, whilst that characterising the restricted principle of relativity is a Lobatchewskian space of constant negative curvature c, equal to the velocity of light, is restated geometrically. It is shown that the triangle of velocities in a Euclidean plane for classical mechanics is replaced by the triangle of pseudo-velocities defined by the relation $v = c \tanh a$ in the Lobatchewskian plane for relativistic mechanics, a denoting the length of the appropriate vector in the respective geodesics drawn on a surface of constant negative curvature. Relativistic mechanics are interpreted in terms of the evaluation of distance by the method suggested by Cayley (1859). It is shown that the pseudo-velocity, defined as above, is equal to the corresponding Cayleyan distance and is therefore projective. It follows that the velocity v of any system S_m with respect to any other system S_n, is given by $v = c \tanh \delta$, where δ denotes the Cayleyan distance $\Sigma_m \Sigma_n$. J. S. G. T.

1402. *Schott's Form of the Dynamics of Relativity.* **M. v. Laue.** (Ann. d. Physik, 73. 3–4. pp. 190–194, Jan., 1924.)—The paper calls attention to the simplification introduced into the mechanics of the special theory of relativity by employing (after Schott, "Electromagnetic Radiation," Cambridge, 1912) the *proper time*, τ, instead of the time, t, in the equations of motion. If $\mathbf{A}$ is the vector potential, ϕ the scalar potential, and $\mathbf{w}$ the vector (x', y', z'), where dashes denote differentiation for τ, the equations become, in rectangular coordinates :

$$\frac{d}{dt}\left(m\mathbf{w} + \frac{e}{c}\mathbf{A}\right) = \nabla\left(\frac{(E - e\Phi)^2}{2mc^2} + \frac{e}{c}(\mathbf{wA})\right)$$

the troublesome square root factor $\sqrt{1 - v^2/c^2}$ having disappeared. These equations differ from the classical ones (apart from the substitution of τ for t), only in the substitution of $(E - e\phi)^2/2mc^2$ for $e\phi$, and the analysis proceeds precisely similarly. M. H. A. N.

1403. *Geometrical Representation of the Special Theory of Relativity, and in particular of the Electromagnetic Field of Bodies in Motion.* **P. Gruner.** (Zeits. f. Physik, 21. 6. pp. 366–371, 1924.)—The author has previously shown [Abstract 2061 (1922)] how the one-dimensional problem of the special relativity theory can be solved by a simple geometrical treatment with two reciprocal orthogonal space-time coordinate systems, work which was extended to two-dimensional space and to the optics of moving bodies by means of the so-called reduced orthogonal coordinates. The latter method is now summarised and generalised, and then applied to three-dimensional space and in particular to the electrodynamics of moving bodies. The paper is entirely mathematical. H. H. Ho.

1404. *On the Axiomatics of the Special Theory of Relativity.* **C. Carathéodory.** (Preuss. Akad. Wiss. Berlin, Ber. 5. pp. 12–27, 1924.)—The axiomatics of the special theory of relativity were established by Einstein and based on certain considerations involving light clocks and measuring rods. The present author now shows how a remarkable simplification can be brought about if the entire theory be based on time observations alone. For example, the axiom for normal light propagation is given without need for length measurements and without previous introduction of the idea of a velocity, as also the time conceptions involved in the terms earlier, later, and simultaneous. In a most natural way the main result of Minkowski is afforded when the general transformations are treated as above. The results of Cunningham and Bateman are quoted. It would appear that when light propagation alone is considered that two spaces which move with constant acceleration relative to each other must be made physically equal, but this not being the case the necessary limitations are made. The paper is in 3 parts, of which section 1 deals in detail with the axioms of light propagation, section 2 considers equivalent spaces with normal light propagation, while section 3 discusses the special relativity principle. It is established generally on the assumption that the transformations of the latter principle form a continuous group, that these transformations must be linear. H. H. Ho.

1405. *Boundary Conditions of the Gravitational Field at Surfaces of Discontinuity.* **N. Sen.** (Ann. d. Physik, 73. 5–6. pp. 365–396, Feb., 1924.)—General covariant analogues are found for the equations, $\partial V/\partial n]_1^2 = 4\pi\sigma$, which give the discontinuity of the normal force at crossing a surface distribution on the Newtonian theory. Provided the g's themselves are continuous the general equations are:

$$\left\{ {km \atop m} \right\}_1^2 v_l - \left\{ {kl \atop s} \right\}_1^2 v_s = \kappa \mathbf{T}_{kl}$$

where v_l is the normal vector to the surface and $\mathbf{T}_{kl}$ is the limit (supposed finite and not zero) of $\int (T_{kl} - \frac{1}{2} g_{kl} T) \sqrt{-g}\, d\omega$ as the thickness of the shell through which it is integrated tends to zero.

In the second part the case of a spherical shell is worked out, and it is shown that in any coordinates which make the g's continuous (these do *not* include the usual r, θ, ϕ, t) the above relation is verified. M. H. A. N.

LIGHT.

1406. *The Optical Behaviour of Metal Surfaces.* **H. Schulz** and **H. Hanemann.** (Zeits. f. Physik, 22. 4. pp. 222–227, 1924.)—The accuracy obtained in the determination of the refractive index of non-absorbing bodies is high, but the accuracy of the results for the optical constants of absorbing materials, such as metals, appears to be much less and to be easily influenced by various conditions. The Maxwell laws are strictly valid, and when deviations of the order of 10 % are found the cause must be some difference in the surface or upper molecular layers. The admissibility of the assumption in Drude's theory of the difference of the upper layers has never been proved and further mathematical development is difficult.

It is suggested by the authors that the "Distribution anisotropy" may play a very important part, since crystals of the regular systems must be anisotropic with respect to their mechanical properties, and it is therefore of interest to consider the deviations from the expected behaviour of an ideal metal surface due to structural peculiarities. The question is considered mathematically, and it is shown that similar results are obtained due to the heterogeneous surface as would be obtained for a Drude surface layer. The question of the behaviour of Pt is discussed, and it is concluded that the effects are not due to a surface layer. The effects of polishing are also mentioned, and it is remarked that using a polished, and hence a nearly structureless surface, on steel, the deviations were removed. W. V. M.

1407. *Refractivity and Atomic Sizes.* **J. E. Calthrop.** (Phil. Mag. 47. pp. 772–779, April, 1924.)—The refractivities of fifteen elements for sodium light are plotted against the cubes of the atomic diameters as determined by crystal analysis. For each vertical column of the periodic table this appears to give a straight line and such deviations as there are are explained by the errors introduced by cubing the atomic radius, itself liable to slight errors. The refractivities are taken from Cuthbertson. Rossotti's expression for the dielectric constant of a gas consisting of perfectly conducting spherical molecules is applied and a formula deduced, $\mu - 1 = KN\sigma^3$. Thus different values of K are appropriate to each group but no obvious relation seems to exist between these values. A. Wh.

1408. *Photographic Density Meter.* **F. C. Toy** and **S. O. Rawling.** (Phot. J. 64. pp. 189–193; Disc., 193–195, April, 1924. Comm. No. 36. from Brit. Phot. Research Assoc. Lab.)—Comparison of two beams with the aid of a selenium cell; adjust until the photoelectric current presents no change. The sensitiveness is greatest in the longer red; but the results can be reduced to the visual results by means of a constant factor which is almost independent of the make of plate. A. D.

1409. *The Effect of Atmospheric Absorption and Diffusion on Signal Lights and Projectors.* **E. Karrer.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 943–953, Nov., 1923.)—Absorption of light by the atmosphere is in general less important than diffusion. Extensive measurements on relative spectral transmission for moist and rainy weather have been recorded by the Bureau of Standards [Abstract 232 (1921)]. A typical curve showing how presence of moisture decreases transmission in the green and blue is presented. One km. of atmosphere on clear and relatively dry days will transmit 97·4 per cent. of daylight, while for moist and rainfall atmosphere the transmission is reduced to 83·6 % and the dominant hue is shifted towards the yellow. Other data are presented showing selective transmission and the effect of water-vapour and oxygen is distinguished from that due to dust and molecules. In the latter part of the paper a series of diagrams is presented showing how the size of the smallest visible target is affected by contrast, and the intensity of diffused light in various directions relative to that of the beam. Other curves show the brightness of the surrounding field as the observer recedes from the lamp, the corresponding change in contrast between field and target, and the least visible target. More information on the diffusion factor for foggy and polluted air is needed. J. S. D.

1410. *The Velocity of Light.* **M. la Rosa.** (Zeits. f. Physik, 21. 6. pp. 333–347, 1924.)—The ballistic hypothesis (that light from a moving body travels with velocity $(c + v)$) gives a remarkably good explanation of the phenomena of double stars, variable stars, and new stars. Einstein's second postulate (the velocity $= c$) is not supported by these phenomena. A. D.

1411. *Tyndall Blue in Solids.* **W. D. Bancroft.** (J. Phys. Chem. 28. pp. 12–25, Jan., 1924.)—The author reviews literature dealing with the blue colouration of glass, slags, porcelain, quartz, and pigments. J. S. G. T.

1412. *Oblique Scattering of Light in Gases and Liquids.* **A. S. Ganesan.** (Phys. Rev. 23. pp. 63–68, Jan., 1924.)—Owing to the feebleness of the scattering effect in gases at ordinary pressures, the incident beam must be very intense and the background against which the track is viewed must be perfectly black. The arrangements employed in the present work to obtain these effects are described in detail. In the case of sunlight the scattered light is assumed to consist of an unpolarised part whose intensity is the same in all directions and a polarised part whose intensity varies as $(1 + \cos^2 \phi)$. This leads to simple equations for the ratio of the two components and for the total intensity for various angles, which are found to agree within 5 % with the experimental results for CO_2 and for dust-free toluene, benzene, and ether. The observed ratios of the intensity for $\phi = 45°$ to that for $\phi = 90°$, are 1·91, 1·79, 1·71, and 2·12 respectively; the observed ratios of the components for $\phi = 90°$ are 0·102, 0·52, 0·48, and 0·084 respectively. For CS_2 the observed ratio is 0·704. A. B. C. L.

1413. *The Tyndall Phenomenon in Liquids.* **R. Gans.** (Zeits. f. Physik, 22. 1–2. pp. 44–50, 1924.)—The present paper is a continuation of a previous investigation [see Abs. 2405 (1923)] and includes necessary corrections and additions to results there recorded. Reference is made to Dieterici's work on cane sugar [see Abstract 159 (1924)] and revised tables are now given for this substance and sodium chloride. Apparatus is then described, with illustrations, for the demonstration of the Tyndall phenomenon in pure liquids. The final section contains a mathematical investigation of a hydrogen cloud in interplanetary space. H. H. Ho.

1414. *Spectro-Photometric Examination of Dyed Threads.* **G. P. Woronkoff.** (Zeits. techn. Physik, 5. 3. pp. 99–107, 1924.)—The dyed threads or fabrics under examination are attached to a microscope cover-glass by means of a preparation of Canada balsam. This preparation has the same refractive index as bleached threads of cotton, wool, and silk, and in consequence the intensity of the transmitted light is not too much diminished. To obtain a uniform field of view the specimen is kept in constant rotation. The absorption coefficient is then measured for various wave-lengths by the ordinary spectro-photometric method. Tables are given showing the wave-length of maximum absorption when threads of wool, cotton, and silk are coloured with a series of dyes. In one or two cases data are given for the absorption coefficient right across the spectrum. Some observations are also added dealing with light reflected from coloured threads. A. A. D.

1415. *Colour Match and Spectral Distribution.* **W. E. Forsythe.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1115–1121, Dec., 1923.)—It has been found experimentally that the light from practically all radiating solids can be matched in colour with the light emitted by a black body at some definite temperature. The colour temperature of a particular source has been defined as the temperature of a black body which has the same distribution of energy in the visible spectrum as the source under consideration. Such colour matches can be easily and quite accurately made on an ordinary photometer bench using a Lummer-Brodhun contrast photometer having a contrast of about 8 per cent. If two sources so radiate that when they are colour matched they have the same spectral distribution, such colour matches can be obtained by measurements of the relative brightnesses of the sources in two parts of the spectrum. If the two sources have the same relative spectral distribution when at a colour match, the two curves that represent their energy distribution can be made to coincide exactly by changing the intensity scale of one of them. The measurements of the relative brightnesses can be made with any form of spectrophotometer or with an optical pyrometer using as the monochromatic screen first a red and then a green glass, or first a red and then a blue glass. The pyrometer lamp may be conveniently calibrated for relative brightness rather than for temperature.

To determine the relation between these brightness ratios and colour temperature a series of red and blue brightness ratios for a black body at different temperatures was measured with a pyrometer calibrated on an arbitrary scale of brightness; then the logarithms of the ratios of the red brightness to the blue brightness (called the red-blue ratio) were plotted against the reciprocal of the temperatures. A very nearly linear relation was found. If a particular red-blue ratio is obtained from measurements on a source studied, its colour temperature under this assumption of colour match for the same red-blue ratio can be found from the point on this curve that has the same red-blue ratio. In studying tungsten a similar series of red-blue ratios was measured and the logarithms of these ratios plotted against the reciprocal temperatures and again the relation was found to be very close to linear. A carbon lamp and a tungsten lamp colour matched by the use of the regular photometer and by the method of the red-blue ratios gave results in good agreement. A tantalum lamp colour matched by direct comparison with the colour standard by a photometer and also by the method of the red-blue ratios showed brightness temperatures obtained by the two methods in good agreement for a number of colour temperatures. Various radiators were studied by the method of the red-blue ratio and the relation between the colour temperature and the brightness temperature for treated and untreated carbon, tungsten, tantalum, osmium, platinum, and the Nernst glower is shown in a table of results. Various substances were examined and when the logarithms of the red-green ratios were plotted against the reciprocal of the colour temperatures as obtained from the red-blue ratios a very nearly linear relation was found. A colour match between carbon and a black body indicates the same spectral distribution. There are small differences in the case of tungsten and of tantalum.

The method of red-blue ratios was used to extend the colour temperature scale. Using the tungsten tube the red-blue ratio for the black body was extended up to about 3000° K., and with gas-filled tungsten lamps up to about 3600° K. the melting-point of tungsten. J. J. S.

1416. *Perception of Brightness in Relation to Colour.* **A. Duschek-Frankfurt.** (Akad. Wiss. Wien, Ber. 131. 2a. No. 3. pp. 171–197, 1922.)—The research is concerned with the relation of the power of perceiving changes in brightness to the brightness, saturation, and colour of the object viewed. For this purpose series of pigments on the Hering scale, graded as regards saturation and colour, were adopted. The photometric arrangements enabling degrees of brightness to be obtained and estimated are described in detail. The principle consists in illuminating the surface with light from a 600-watt gas-filled lamp, a second smaller lamp being used to cast a shadow of a rod. The observer regulated the distance of the small lamp until this shadow became imperceptible. The data are assembled in numerous tables and corresponding diagrams. For various pigments the relation $\eta = A + B \log H$, where η is the power of perceiving changes in brightness and H is the brightness, was deduced. It appears that the Weber law according to which $\eta =$ constant applies only to a certain critical saturation, but is considered sufficiently accurate in the case of blue-green, red, and yellow spectrum colours. J. S. D.

1417. *Studies Based on the Spectral Complementaries. Subjective Saturation of Spectral Hues. Individual Variations of the Normal Colour Sense.* **R. H. Sinden.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1123–1153, Dec., 1923.)—This paper contains data relating to the wave-lengths of spectral complementary hues which are strictly comparable and which correspond to a white of definitely known spectral constituency. Eight observers (each with fairly normal colour vision) have been examined for complementary wave-lengths, and in addition five of them have furnished the luminosity ratios of the complementaries. The experiments have been carried out using a Brace spectrophotometer, the luminosities of the coloured stimuli being determined by a modification of the direct equality-of-brightness method. Each observer has found the complementary wave-lengths to four given stimuli, and there is good agreement between them. There are, however, large discrepancies between the observers with regard to the estimates of the luminosity ratios. The subjective saturation of the spectral colours is deduced from the data provided by one observer, on the assumption that the subjective saturations of two complementaries are inversely proportional to their luminosities. The differences to be observed between the present results and those given by Trolland are not of great significance.

A discussion of the variations between the different observers with regard to their selection of the complementary hues follows. It is concluded that the results of the present and previous investigations fail to reveal inherent variations in the complementary wave-lengths of separate individuals other than can be accounted for by differences in the absorptive properties of the ocular media, and that if variations of other types occur, they are so small as to be barely detectable through the greatest attainable accuracy in colour matching. With regard to the variation of the luminosity data from one individual to another no definite conclusion is arrived at as to its cause. Experiments are described in which correction is made for the absorption of the ocular media but even then there are marked discrepancies between the results provided by different observers. A. A. D.

1418. *Determination of Colour in Terms of Dominant Wave-Length, Purity, and Brightness.* **I. G. Priest.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 173–200, Jan., 1924.)—This is a most elaborate account of the "monochromatic colorimeter" in use at the Bureau of Standards. In addition to the details of the main instrument a full account is given of all the accessory arrangements (particularly the lamps), together with a comprehensive explanation of how a test is carried out. The apparatus is designed for the determination of the dominant wave-length, brightness, and purity of the resulting beam when white light corresponding to a Planckian radiator of known temperature is transmitted through, or reflected from, the sample under test. The sample is placed over an aperture in the diffusion sphere, wherein is a standard lamp. The light from the sample (either by transmission or reflection) passes to one-half of a photometric cube, and is there matched by a mixture of white light from one source and homogeneous light obtained spectroscopically from another source. The brightness of the white light in the "mixture" field is then determined by a flicker photometer, the sample field and the homogeneous fields being screened. Subsequently the brightness of the homogeneous beam is determined, its wave-length, of course, being known. This gives the full data required. Finally, there is a discussion of the validity of the additivity of homogeneous and white brightness, and it is concluded that with certain limitations it may be taken that such addition is experimentally justified. A. A. D.

1419. *Reflex Visual Sensations.* **F. Allen.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 583–626, Aug., and pp. 913–942, Nov., 1923.)—In the first section of the paper the author gives a brief survey of previous work, involving the use of the "critical frequency" of flicker to detect difference in behaviour of the eye in a fatigued and unfatigued condition. The measurements in this case were made with the right eye, which was in daylight adaptation whilst the left eye was fatigued with light from some portion of the spectrum. It was found that the stimulus applied to the left eye was transferred to the right by some reflex process. As a result, the brightness of three colours—red, green, and violet—was enhanced. Six colours were found which produced no effect, and the reflex and normal curves always coincided in two places near $0{\cdot}653\,\mu$ and $0{\cdot}50\,\mu$. The reflex action was greatest for violet and is apparently an inverse function of wave-length. The results are illustrated by numerous diagrams, and the resultant of all the reflex curves can be regarded as equivalent to the effect of white light which enhances the brightness of all parts of the spectrum. On the other hand, darkness adaptation of one eye causes a diminution in brightness of the whole spectrum. In conclusion, the results are discussed in relation to various theories of colour-vision, and such effects as successive contrast, binocular contrast, and the cause of the "whiteness" underlying all colour-sensations.

J. S. D.

1420. *The Speed of Vision.* **P. W. Cobb.** (Am. Illum. Eng. Soc., Trans. 19. pp. 150–163; Disc., 163–175, Feb., 1924.)—The time required for light to make an adequate visual impression depends upon many conditions of vision such as: The size and distance of the object; its brightness compared with that of its background; the general level of brightness; whether vision of form is necessary or the simple "picking-up" of the object; and the reduction in effectiveness of the image of the object due to images of other objects seen immediately before and after it.

It is shown experimentally that between the limits of 1 and 100 millilamberts brightness (the millilambert—ml.—is the brightness resulting when a diffusing surface of 93 per cent. reflection factor is subject to one foot-candle illumination), corresponding to about 1 to 100 foot-candles illumination upon a white surface, and to illuminations greater than this on most surfaces, the speed of visual impression due to a test-object rising out of a clear field is increased by a constant amount each time the brightness is increased by a constant factor, whether the subject is required to recognise form or merely to report the presence of the test object. The effect of the confusion due to previous and following patterns, *i.e.* when the test-object rises out of a confused field, is to reduce the speed of impression, and this effect is greater at high brightnesses than at low; while the actual additional time consumed which so reduces the speed is not greater at high brightness than at low. An increase in the scale of the test-object and confusion patterns increases the speed over that found with smaller patterns at any brightness, but the speed in the case of a larger object reaches a maximum at lower brightness than it does in the case of a smaller object. These results may lead in practice to a classification of visual conditions tending to the appraisal of the probable increase in industrial production due to improved lighting.

J. J. S.

1421. *The Minimum of Energy in the Luminous Excitation of the Retina by Brief Illuminations.* **H. Piéron.** (Comptes Rendus, 178. pp. 966–968, March 10, 1924.)—The author replies to the criticisms of Blondel and Rey [Abstracts 1128 (1924)] on his former paper. He disclaims having invoked the "inertia" of the retina. It has been shown by various researches that there is an optimum duration of excitation, a minimum of energy: with times very short the threshold energy rises. For visual reception which implies a photochemical process followed by an excitation of nerve it would be very surprising that the law of optimum duration should not hold. The cause of error invoked by Blondel and Rey was considered by the author and having made experiments with different surfaces of excitation he found, contrary to what would have occurred from the action of this cause of error, the minimum of energy for longer durations with smaller surfaces. In identical conditions the minimum of energy occurs for a more brief duration in the excitation of the rods than in that of the cones. On the other hand, in the researches of Blondel and Rey where a point illumination is used, there intervenes an important source of error. The minimum diameter of the receiving elements being from 30″ to 45″ the inevitable changes of projection of the illumination on the retina bring in enormous variations of visibility. It is not surprising therefore that the fortuitous variations of observers unequally trained, under conditions of lighting besides insufficiently defined, and with little fixation, should mask systematic variations which are not considerable. However, it is certain that the increase of energy for very brief durations would appear with more certainty if correct determinations could be made with durations of the order of the millionth of a second. This offers practical difficulties which are, however, not insurmountable. J. J. S.

1422. *The Reflex Origin of the Self-Light of the Retina.* **F. Allen.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 275–286, Feb., 1924.)—The author endeavours to explain the self-light of the retina, in terms of reflex action, quoting from Peddie's recent work on Colour Vision, in which numerous references to the self-light are made. The writer has shown that every colour stimulates by reflex action the sensations of red, green, and violet and enhances the sensitiveness of their reception [see Abstract 1419 (1924)]. Equal stimulation of all three sensations causes the perception of white, and it is believed that whiteness is a separate fundamental sensation. The author quotes various theories in support of this view. Whiteness of mixtures reaches its extreme in the case of complementary colours and complementariness is practically determined in presence of self-light. Peddie's definition of the threshold value implies that this is closely associated with, and may be entirely due to self-light. The insensitiveness of the fovea to weak light may be due to inherent functional conditions, but may also be due to excitation, not necessarily visible, of self-light in this region. The existence of self-light has given rise to the conception of "degrees of blackness." There is probably a close connection between self-light phenomena and the changes in the mechanical pressure on the retina due to variations in blood-pressure. J. S. D.

1423. *Camera Lenses of Large Relative Aperture for Stellar Spectrographs.* **G. W. Moffitt.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 365–371, Feb., 1924.)—The author has obtained formulæ for the design of an F/3 projection lens which enables it to be used as a spectrograph lens of high relative aperture, and he describes one, made for Dr. Plaskett, in which borosilicate crown and medium flint glasses are used, a diagram being given of approximately correct proportions. Such a lens for astronomical purposes involves: (*a*) A "flat" spherical aberration curve; (*b*) coma must be eliminated; (*c*) for any given field angle, the upper and lower rays should be traced, and these should intersect the chief ray at the point where the primary image is located; (*d*) the primary image surface must lie in the plate plane; (*e*) and the primary image of a distant point source must be a straight line. The general conditions are not so severe as for high-grade photographic anastigmats, but the small permissible values of the residual aberrations make precise adjustment imperative. The actual lens made works well with three-prism and two-prism dispersion, but with one-prism the field becomes so convex towards the lens that the photographic plates cannot be bent safely so as to fit the curvature of the image surface. The cause of the failure with one-prism dispersion is found chiefly in the residual chromatic aberration of the collimator lens, and partly in that of the camera lens. A flat field with a one-prism dispersion can be obtained either by eliminating the secondary colour or by introducing sufficient real curvature of the primary field to counteract the secondary spectrum effect; the latter is preferable and could be obtained by developing interchangeable camera lenses, specially corrected for the various uses. A. S. D. M.

1424. *Prism System for Small Broken Telescopes.* **G. W. Moffitt.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8, pp. 361–363, Feb., 1924.)—Describes a new form of prism to replace the roof prism used in elbow telescopes. The practical form of the prism is shown in the paper. It may be regarded as built up from four right-angle reflecting prisms. The length of the glass path and the number of total reflections are the same as in the ordinary Porro erecting system, and the new system tends to flatten the field of the objective. It has been found to be free from ghosts which are likely to be objectionable in an instrument of the type considered. Its chief advantage is that the high accuracy necessary in a roof prism is not demanded. J. W. T. W.

1425. *An Actinometer to Measure Ultra-Violet Radiation.* **B. Szilard.** (Comptes Rendus, 178. pp. 808–810, Feb. 25, 1924.)—The radiation is focused by a quartz lens on a photoelectric cell in which the kathode is of specially prepared cadium. The intensity of the current transmitted by the cell is proportional to the intensity of the incident radiation and is measured by an electrometer. The cell is surrounded by a metal case to prevent electrostatic disturbances, and is sensitive in the region 3900–2950 A. A. W. L.

1426. *Photoelectric Microphotometer for Photographic Densities.* **J. O. Perrine.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 381–387, Feb., 1924.)—The photographic plate to be examined is placed in front of a narrow illuminated slit and the light passing through the different portions of the blackened area allowed to fall on a photoelectric cell placed below the plates. The intensity of the light was assumed to be proportional to the current produced and, in turn, proportional to the galvanometer deflections. A. B. W.

1427. *Low Brightness Photometer.* **E. Karrer** and **A. Poritsky.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 355–359, Feb., 1924.)—Describes a photometer devised for measuring the brightness of small areas of low candle-power. The Maxwell view is employed, as in the case of the Fabry-Buisson instrument [see Abstract 1409 (1920)], for the surface whose brightness is to be measured, but the comparison surface consists of an aperture in a small whitened sphere. The brightness of this comparison surface is controlled by means of a diaphragm which is placed over a second opening in the sphere so as to limit the amount of flux entering. This flux is supplied from a second sphere containing a small electric lamp. Full structural details are given in the paper. The field of view is that of an equality of brightness (concentric) Lummer-Brodhun cube. J. W. T. W.

1428. *The Optical Parts of the Victoria Spectrograph.* **J. S. Plaskett.** (Astrophys. J. 59. pp. 65–75, March, 1924.)—The optical system originally planned for the Victoria spectrograph, owing to war and other conditions has had to be considerably modified, and this paper gives the results of tests of the field curvatures of four different types of camera objectives with one, two and three prisms. The original, medium-focus triplet gives beautiful definition and a field flat to less than 0·1 mm. over the whole visible spectrum with one prism; but with two and three prisms, it is strongly concave. This curious behaviour is ascribed to the chromatic aberration of collimator and camera, which tends to make the field convex, being exactly neutralised by the normal concave field curvature of the camera with the dispersion of one prism, while with greater dispersion the concavity of field overcomes the chromatic effect. A shorter-focus triplet of nearly the same type behaves very similarly. Particulars are also given of a new modified Petzval type and the Ross wide field astronomical lens. AUTHOR.

1429. *Six-Prism Glass Spectrograph.* **J. S. Foster.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 373–379, Feb., 1924.)—The instrument was designed for investigation of the Stark effect in gases. The dispersion needs to be variable according to the part of the spectrum investigated and the strength of the line to be recorded. Also the instrument needs to be rigid on account of long exposures. The collimator and camera lenses are Hastings-Brashear doublets of 115 cm. focal length and 7·6 cm. aperture. The six prisms were made by Krüss and reground by Brashear. The faces are circular and 6·0 cm. in diameter. The prisms are placed on a flat cast-iron base 25 cm. in diameter provided with levelling screws. A special cover has been devised in sections to allow of the number of prisms being varied. The camera and collimator are supported on stands of heavy iron pipe. The plate-holder and its frame are of aluminium and take a plate 20 cm. by 3 cm. Several exposures can be made on one plate and adjustment made for tilt. With six prisms the dispersion is 2 Å. per mm. in the violet. The Stark components of the 4388 helium line are shown as an example of the work done with three prisms. An improved method of testing the density of a neutral wedge is described. F. S.

1430. *Automatic Focus Finder for Ultra-Violet Photomicrography.* **W. T. Bovie and C. E. Barr.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1167–1174, Dec., 1923.)—Describes a mechanical device for enabling the exact focus for the ultra-violet light used for taking a microphotograph to be obtained from the position for best focus using visible light in a particular narrow band in the yellow-green. The light filter used for obtaining this band is described in the paper. The change of focus is produced by the rotation of a screw through a few turns between automatic stops. The constructional details of the device and the method of calibrating it are described in full. J. W. T. W.

1431. *Study of Astrographic Objectives by Method of Extrafocal Images.* **G. Demetrescu.** (Rev. d'Optique, 2. pp. 452–469, Nov., and pp. 493–501, Dec., 1923.)—Hartmann brought photography and calculation to bear on the Foucault-Ritchey method. The author shows that Hartmann's *criterion* T (where $T = 100000/F \times \Sigma rd/\Sigma r$ and $d = 2r \mid u - u_0 \mid /F$) first, has no physical precision, since the values $\mid u - u_0 \mid$ are absolute, and d does not retain its natural sign, but is positive always; and, second, T takes no account of astigmatism. He therefore divides the diaphragm into a certain number of equal squares, at whose centres are the openings for the rays, which are made to fall upon a plane which is always perpendicular to the axis of symmetry of the objective. Thus there are obtained a group of points, and the concentration of the points is a measure of the luminous intensity of the image. The concentration is evaluated by the moment of inertia of the group with respect to its centre of gravity; the section of maximum concentration is thus found. It is sufficient to direct the objective, on which a suitable diaphragm is placed, to a star, and make two exposures, with the plate inside and outside the focus. To counteract chromatic aberration a colour screen is used. He obtains two criteria: $s = 2R\sigma_1''$, and $c = 1/10 \times F\sigma_1''/2R$, where σ_1'' is the geometrical separating power and 2R the diameter of the objective. The coefficient s is analogous to the separation constant defined by the theory of diffraction; the coefficient c can be used as a test of the geometrical separating power of objectives of the same qualities and different diameters. The influence of the colour screen is to bring the two focals and the section of maximum concentration nearer to each other by a constant quantity without introducing changes either in the form of the focal surfaces or in their relative positions. In the second part of the paper, the method is applied to the study of the objective of the Bucharest Observatory, and it is compared with other objectives, especially with that of the Paris Observatory. A. S. D. M.

1432. *Accuracy in Optical Measurement.* **A. A. Michelson.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 321–328, Feb., 1924.)—The limits of accuracy obtainable in observations with the telescope, microscope, interferometer, and spectroscope are discussed. J. J. S.

1433. *Ultramicroscopy with Unilateral Illumination.* **A. Szegvari.** (Zeits. f. Physik, 21. 6. pp. 348–357, 1924.)—Mie's theoretical deductions [Abstract 594 (1908)] confirmed by unsymmetrical illumination of an out-of-focus disc-image produced by an ultramicroscopic particle under unidirectional lateral illumination. If the particle be approximately spherical, the asymmetry is the same (but differently orientated) for all azimuths of illumination; if the particle be unsymmetrical, the degree of asymmetry of illumination depends upon the azimuth of the incident light, and if it be also mobile (Brownian movement) it suddenly passes from favourable to unfavourable positions, or *vice versa*, and flashes are observed. A. D.

1434. *Measurements of Spectral Transmission.* **I. G. Priest, H. J. McNicholas, and M. Katherine Frehafer.** (Optical Soc. of America,

J. and Rev. Sci. Inst. 8. pp. 201–212, Jan., 1924.)—An account of the results of tests of the precision and accuracy of spectrophotometric measurements. The Koenig-Martens spectrophotometer of the Bureau of Standards was tested by measuring the transmissions of rotating sectored discs of known angular aperture. Measurements of the spectral transmission of blue filters by different observers were also compared. The photometric probable error at various wave-lengths has been computed from the observations of three different observers. The experimental results are given in tables and graphs and lead to the following conclusions: (1) For heterogeneous illumination the probable error of a single observation is about 0·7 per cent. of the transmission when measurements are made at the field brightness most favourable to accurate watching. (2) For homogeneous illumination the probable error of a single observation of transmission 0·37 is nearly constant and is about one per cent. of the transmission in the case of the following wave-lengths of Hg, 435·8 and 546·1 $m\mu$, and of He, 447·2, 492·2, 501·6, 667·8, and 706·5 $m\mu$. (3) For heterogeneous illumination the actual error of the mean of ten observations for transmissions even as low as 0·015 and for wave-lengths between 430 and 700 $m\mu$ is usually less than 1 per cent. of the transmission if it is not changing rapidly with wave-length. (4) There is no systematic error of measured transmission with respect to wave-length. J. J. S.

1435. *Quantum Optics.* **G. Wentzel.** (Zeits. f. Physik, 22. 3. pp. 193–199, 1924.)—A mathematical investigation with the object of helping to reconcile the contradictions between the wave theory of interference and polarisation on the one hand and the quantum theory of the spectral lines on the other. J. J. S.

1436. *Effect of a Retarding Plate on White Light Interferometer Fringes.* **N. K. Sethi.** (Phys. Rev. 23. pp. 69–74, Jan., 1924.)—Introduction of a thick glass plate with plane-parallel sides into one of the interfering beams in the Michelson's interferometer replaces the usual few straight white light fringes by a very large number of circular rings, the number being diminished by partial monochromatising of the light. Spectroscopic examination of the rings shows that the increase in number is due to the production of interference in different places by different parts of the spectrum. The corresponding formulæ are quantitatively verified by using them to determine the dispersion of the glass plate employed. Two other examples of this dispersion of white light fringes are quoted and it is pointed out that the increase in the number of white-light fringes observed by Wood on introducing sodium vapour into the interferometer path also involves the same process and is not due to achromatisation as suggested by him. Although the fringes are fainter than the first-order white of Newton's scale, owing to the effect of colour-contrast, they can be clearly distinguished by the eye. A. B. C. L.

1437. *Effect of the Material of the Sides of Deep Slits on the Intensity of the Light Transmitted.* **C. R. Smith.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1069–1077, Dec., 1923.)—When light is passed through a narrow deep slit there is not only strong polarisation but also marked absorption which is related to the wave-length of the light, the depth of the slit, the width of the slit and the material of which the walls of the slit are composed. In the experiments described to determine the

effect of the material of the walls of the slit the general arrangement resembled that employed by Sieg and Fant. The depth of the slit was 2·31 cm. and it passed between pairs of small blocks of steel which were plated electrolytically with the metals nickel, copper, silver, and gold, partially polished and maintained with surfaces flat to within 0·0001 cm. The results obtained were somewhat irregular, but the curves indicating the comparative effects show that differences in intensity of the light transmitted by a deep slit are produced by changing the material though the other conditions are kept constant. No account was taken in the experiments of the condition of the light with respect to polarisation.
J. J. S.

1438. *The Illumination of a Surface by a Spectroscopic Slit.* **A. Hnatek.** (Zeits. f. Physik, 22. 3. pp. 186–192, 1924.)—The standard works on photometry contain no account of the case of plane illumination by means of a narrow slit, and the present investigation has been undertaken for such purpose, the assumption being made that the plane concerned is parallel to the plane of the slit. The paper is entirely mathematical.
H. H. Ho.

1439. *An Early Formulation by Stokes of the Theories of the Rotatory Polarisation of Light.* **J. Larmor.** (Cambridge Phil. Soc., Proc. 22. pp. 76–81, Feb., 1924.)—The two letters now communicated are from G. G. Stokes to W. Thomson of dates December 12–13, 1848, three years after Faraday's great magneto-optic discovery. They formulated already the permissible types for general equations of propagation, virtually on the basis of the very modern criterion of invariance, relative to all changes of the spatial frame of reference in the case of active fluids, but having regard to the fixed direction of the extraneous magnetic field in the Faraday case. Their form was elucidated in each case by correlation with a remarkable and significant type of rotational stress in a propagating medium.
H. H. Ho.

1440. *A New Measurement of the Pressure of Radiation.* **A. Golsen.** (Ann. d. Physik, 73. 7–8. pp. 624–642, March, 1924.)—These measurements have been carried out using three foils of platinum, nickel, and aluminium respectively. The foil under test is fixed to a horizontal arm suspended by a quartz fibre (torsion balance method), the foil being deflected from its equilibrium position by the pressure of the radiation from a source of constant known intensity. The pressure of the gas in the vessel in which the foil hangs was carried down to 10^{-6} mm. of Hg. It is concluded that the disturbing effect of radiometer action ceases at about 10^{-5} mm., although this limiting value varies from one material to another—a variation bound up with the presence of occluded gases in the foils. Below this limiting pressure the deflection of the suspended system is independent of the pressure for a constant intensity of radiation. The absorption coefficients of the foils were measured by a subsidiary experiment and the radiation pressure determined. The results from the different foils show good agreement between themselves and they also agree within a maximum error of 6 % with the values calculated from the Maxwell-Bartoli equation.
A. A. D.

1441. *Rotatory Dispersion of Tartaric Acid.* **L. Longchambon.** (Comptes Rendus, 178. pp. 951–953, March 10, 1924.)—Crystalline tartaric acid, when examined by light travelling along the optic axis, exhibits a normal rotatory dispersion, with $\alpha_{5780} = 11 \cdot 2°$ per mm. and $\alpha_{4358}/\alpha_{5780} = 2 \cdot 14$. This lævo-rotatory form of the acid, which has a specific rotatory power $[\alpha]_{5780} = 70°$, is described as α-tartaric acid. By a process of extrapolation the conclusion is drawn that at infinite dilution tartaric acid in aqueous solution would have a specific rotatory power $[\alpha]_{5780} = +15°$ and a dispersion-ratio 1·3. This product is described as β-tartaric acid. T. M. L.

1442. *Geometrical Discussion of Optical Activity in Crystals.* **H. Chipart.** (Comptes Rendus, 178. pp. 995–996, March 17, 1924.)—The author has divided the 32 systems of crystal-symmetry into 15 which can propagate elliptical vibrations and which can therefore develop optical rotatory power, and 17 which can only propagate rectilinear vibrations and cannot develop optical rotatory power. This conclusion, already arrived at in another way by Willard Gibbs in 1882, has been disputed by some physicists, who regard the absence of a centre of symmetry as a sufficient criterion of the possibility of optical rotatory power, and thereby transfer six systems from the latter to the former group. The author maintains the correctness of his own classification. T. M. L.

1443. *Mutarotation of Glucose.* **H. v. Euler, K. Myrbäck,** and **E. Rudberg.** (Archiv f. Kem., Min. o. Geologie, Stockholm, 8. No. 28. pp. 1–9, 1923. In German.)—The authors suggest that the first step in the mutarotation of glucose is the addition of a proton to the oxidic oxygen, converting the molecule into a kation, and that this is followed either by a molecular rearrangement or by a breaking of the lactone ring. The experimental part of the paper consists of a redetermination of the dissociation-constant of glucose by an electrometric measurement of the hydrogen-ion concentration of sodium hydroxide with and without glucose, giving the values $11 \cdot 6 \times 10^{-13}$ at 18° and 45×10^{-13} at 40°. The influence of temperature is also discussed. T. M. L.

1444. *On the Relation between Time and Intensity in Photographic Exposure.* **L. A. Jones** and **E. Huse.** (Eastman Kodak Co. Research Lab. Comm. No. 193. Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1079–1113, Dec., 1923.)—A preliminary account is given of the Bunsen-Roscoe reciprocity law which states that the intensity of the acting radiation I, the time during which it acts, t, and the resulting exposure E are related as follows $E = I \cdot t$. Reference is made to the results of various observers, that this law fails to agree with experimental observations. In particular the work of Scheiner, Abney, Schwarzschild, Eder, Sheppard and Mees, and Helmick is mentioned. The present paper describes the methods employed and the results of researches, occupying a period of several years at the Eastman Laboratory, during which a large amount of reliable data was obtained. A detailed description of the apparatus employed, the photographic materials, development and density measurements, is given, together with an account of the experimental procedure. The results of the density and exposure measurements are plotted in the usual density-log (exposure) forms for different values, and for both plates and cinema positive and negative films. The conclusions arrived at are: (1) That the reciprocity law of Bunsen and Roscoe fails definitely in the case of the three materials used. (2) In the Schwarzschild expression $E = It^p$, the index p is not constant, as has been assumed. (3) The experimental determination of the value of optical intensity must be subject to considerable uncertainty due to the extreme flatness of the characteristic curves. For the Seed 30 and 23 plates, all characteristic curves determined on the basis of the time scale give equal *gamma* values when developed to the same extent, or in other words *gamma* is independent of the intensity. In the case of cine positive film, however, *gamma* is dependent partly upon the intensity. The authors state that the work carried out still leaves many questions unanswered, and mention that investigations are proceeding on the dependence of the failure of the law upon the wave-length of the exposing radiation. A. W. J.

1445. *Luminous Impact, Illumination during Recombination, and Excitation Function.* **R. Seeliger.** (Phys. Zeits. 25. pp. 56–60, Feb. 1, 1924.)—The variation in results respecting the form of the excitation function of a spectral line as given by different methods is discussed in the present paper, and the necessity shown for a more precise definition of this function. A distinction must be drawn between the excitation function of a term, and that of a spectral line, *i.e.* the transition probability between the terms associated with the line. The kinetic method of Sponer [see Abstract 891 (1922)] measures the former, while the optical methods of Hughes and Lowe determine the latter, but not in a way capable of exact definition. The clearest viewpoint was obtained by separating the impact illumination, for which excitation the atomic electron does not leave the atom, and the illumination due to recombination, for which production the previous ionisation of the atom is necessary. The indefinite character of previous optical work is now shown to be due to the fact that the optical methods, according to the special experimental conditions adopted, investigate a mixture of impact and recombination illuminations, whereas above the ionisation potential only the recombination effect is determined according to the results of Bartels. [See Abstract 1166 (1924).] H. H. Ho.

1446. *The Fluorescence Yield from Dyestuff Solutions.* **S. J. Wawilow.** (Zeits. f. Physik, 22. 4. pp. 266–272, 1924.)—Corresponding to the Warburg idea of photochemical yield, the fraction of the absorbed radiation which is transformed into the energy of the secondary fluorescence radiated is now termed "fluorescence yield" and denoted by k. For the resonance radiation in dilute gases, mercury and sodium vapour, data have been supplied by Wood and Dunoyer, and exact determinations have been made by Paschen for ionised helium in the ultra-red, in which cases k appears to be nearly unity. For the fluorescence of solid bodies and liquids, in particular dyestuff solutions, the experimental determination of k is rendered difficult by the width of the absorption and fluorescence bands and also by the Stokes displacement. A spectral photometric method is now described for this purpose which enables the determination of the fluorescence yield to a first approximation. Results are given for fluorescein, magdala red, various rhodamines, eosin, acridine red, erythrosin, and uranium glass. The concentrations of the dyestuffs were varied from 10^{-5} to 10^{-6} g./cm.^{3}. It appears that for the case of fluorescein, $k = 0{\cdot}80$, and that the absorbed radiation is almost entirely transformed into the secondary variety. Observations with very concentrated solutions (10^{-3} to 10^{-4} g./cm.^{3}) in thin layers (0·3 mm.) are briefly described and k found to decrease very rapidly with concentration while the absorption spectra exhibit changes. H. H. Ho.

1447. *The Sensibilised Fluorescence of Lead and Bismuth Vapour.* **H. Kopferman.** (Zeits. f. Physik, 21. 5. pp. 316–325, 1924.)—The results of previous work on this subject by Franck and Cario are first summarised [see Abstract 2410 (1923)], following which comes a detailed description of experiments on the sensibilised fluorescence of lead and bismuth vapour in which appear the lines: $\lambda = 4057 \cdot 93$ Å.; 3683·60 Å.; 3639·71 Å.; 2873·40 Å. and 2833·17 Å. for the lead arc spectrum, and 4722·72 Å. and 3067·81 Å. for the bismuth arc spectrum. The lead lines observed are in agreement with the Thorsen-Grotrian series scheme. From the bismuth observations further regularities in the bismuth arc spectrum have been recognised. H. H. Ho.

1448. *The Photoluminescence of Flames. Part II.* **E. L. Nichols** and **H. L. Howes.** (Phys. Rev. 23. pp. 472–477, April, 1924.)—Study of a new flat hydrogen flame showed that the sensitiveness to excitation noted in previous work [Abstract 486 (1924)], is confined chiefly to the boundary between the oxidising and reducing regions. When excited by exposure to light from an amalgam arc, measurements of the positions of the edges of the bands and of the intensities of the maxima and minima showed that the effect of excitation was to decrease the width of the bands and to increase the sharpness and the intensity of the maxima, for *flames salted with Ba, Ca, and Sr. In the case of Tl*, the green line was increased in brightness more than 50 times. This effect was traced in the presence of Tl in the arc, and by dispersing the light so as to use only narrow spectral regions, it was found that the Th lines 5351, 3776, and 3519 Å. excite the flame, whereas neighbouring mercury lines are inactive. The luminescence is thus shown to be selective and to be closely analogous to the so-called resonance radiation of vapours. AUTHORS.

1449. *A Method for the Estimation of the Average Life of Excited Mercury Atoms.* **L. A. Turner.** (Phys. Rev. 23. pp. 464–471, April, 1924.)—(1) *In mixtures with hydrogen, computed from rate of dissociation of hydrogen,* found by Franck and Cario. A theory is developed which gives the relation between the rate of dissociation of H_2 molecules by collision with excited Hg atoms and the pressure of H_2, when the rate of production of excited Hg atoms is kept constant. It is shown to be in accord with Franck and Cario's experimental results, leading to a value for $\sigma^2\tau$ of $7 \cdot 22 \; 10^{-22}$, where σ is the distance between centres of H_2 molecules and excited Hg atoms at a collision and τ is the average duration of the excited state. Assuming σ to be of the order of magnitude of atomic diameters, τ is found to be about 10^{-7} sec. The equation derived here and a different one of Cario's are compared and the former found to be in better agreement with experiment. (2) *In mixtures with air, computed from diminution of the fluorescence by adding air,* found by R. W. Wood. The same theory is applied to the fluorescence experiments of Wood, assuming a constant rate of production of excited atoms, but the agreement is not good. The theory is extended to cover the possibility of successive impacts of the excited Hg atom, and the form of the relation is found to be the same in this case. It is found that the theory does accord qualitatively with the experimental data of higher pressures, indicating an increased rate of production of excited Hg atoms for the same illumination, and a smaller value of τ with air than with H_2. AUTHOR.

1450. *The Size of the Einstein Light Quanta.* **L. S. Ornstein** and **H. C. Burger.** (Zeits. f. Physik, 20. 6. pp. 345–350, 1924.)—The conditions of equilibrium between a cloud of electrons and black radiation are investigated with the hypothesis of point-radiation as basis. If, before a collision, the electron has velocities v_x, v_y, v_z, the light quantum frequency ν and direction α, β, γ, and if dashed letters denote the same quantities afterwards, the equations are:

$$h\nu + \tfrac{1}{2}m(v_x^2 + v_y^2 + v_z^2) = h\nu' + \tfrac{1}{2}m(v_x'^2 + v_y'^2 + v_z'^2),$$
$$h\nu\alpha/c + mv_x = h\nu'\alpha'/c + mv'_x, \text{ etc.}$$

If it be assumed that the changes in v and ν are small, and also that v/c is small, these equations give, with an obvious notation, $\Delta\nu = -\nu\Sigma(\alpha - \alpha')v_x/c$, $\Delta v_x = h\nu(\alpha - \alpha')/mc$. It is now assumed that the quantum has a certain finite collision area $O(\nu)$, a function of ν only, and from the equality of the number of collisions in which undashed quantities change to dashed with the number of collisions in which the reverse occurs, the equation $O(\nu)n(\nu)f(v) = O(\nu')n(\nu')f(v')$ is found, where $n(\nu)d\nu$ and $f(v)dv$ denote respectively the number of quanta with frequency between ν and $\nu + d\nu$, and the number of electrons with velocities between v and $v + dv$. Assuming Wien's law of radiation, Maxwell's law of distribution for the velocities and using the values found for $\Delta\nu$ and Δv, this gives $O(\nu) = C/\nu^2 = a\lambda^2$, where a is a pure number.

The use of the Wien law, and not the exact Planck formula, is justified by the fact that when ν decreases the collision area increases and the quanta interpenetrate. M. H. A. N.

1451. *Light Quanta and the Planck Law.* **L. S. Ornstein** and **H. C. Burger.** (Zeits. f. Physik, 21. 6. pp. 358–365, 1924.)—It has been shown previously [see Abstract 1078 (1924)] that a gas-kinetic treatment of the equilibrium of light quanta and electrons is possible, under the assumption that the light quanta possess an effective sphere whose radius is proportional to the wave-length of the quantum. On this assumption, however, it proved only possible to derive the Wien law, and without special hypotheses the conditions for the equilibrium of dark radiation and free electrons could not be stated. The cause of this result was due to the quantum gas being regarded as infinitely dilute, so that two quanta could never collide with the same electron at once. The present investigation now treats the case of repeated impacts, and, to avoid complication, is restricted to the linear case, *i.e.* light quanta and electrons moving only along a straight line. A mode of calculation is then devised which can be easily extended to the more general case, and which is in agreement with the Planck law. The paper is mathematical throughout. H. H. Ho.

1452. *A Criticism of the Papers "The Dimensions of the Einstein Light Quanta" and "The Dynamics of the Impact between a Light Quantum and an Electron" recently published by L. S. Ornstein and H. C. Burger.* **W. Pauli, Jr.** (Zeits. f. Physik, 22. 4. pp. 261–265, 1924.)—This criticism deals with the relationship between the matter of the above-named papers and the published work of the author. In Section 1, the conclusion of Ornstein and Burger that the Wien radiation law may be obtained without any special hypothesis is now shown to imply that the considerations of these authors are limited to the case of the validity of the Wien law, whereas generally it is the Planck radiation law which holds good. Section 2 deals with the frequency of the fundamental element processes and points out the existence of an undetermined function which for short-wave radiation is still an unsolved problem. Section 3 discusses mathematically the various formulæ concerned, and in Section 4, the author contends that the model proposed by Ornstein and Burger is invalid. [See preceding Abstracts and 1078 (1924).] H. H. Ho.

1453. *The Reciprocal Action between Radiation and Free Electrons.* **W. Bothe.** (Zeits. f. Physik, 23. 3–4. pp. 214–224, 1924.)—Pauli's investigation of the thermal equilibrium between radiation and free electrons is first briefly described, the two kinds of processes involved being discussed. The primary object of the paper is then to show that by a very simple and natural modification of the Compton-Pauli hypothesis the second of the Pauli processes can be rendered unnecessary. This is achieved by an application of the ideas of the polyquantic radiation molecule to the reciprocal action between radiation and free electrons. The proposed alteration of the Pauli hypothesis for the element processes is shown to offer many advantages. Correspondence considerations of the Brownian movement in the stationary radiation field lead to the result that the scattering coefficient of free electrons for long-wave radiation is independent of the structure and frequency of the radiation [Abstract 1078 (1924) and preceding abstract should be consulted]. The paper is entirely mathematical. H. H. Ho.

1454. *The Intensity of Repeated Spectral Lines.* **H. B. Dorgelo.** (Zeits. f. Physik, 22. 3. pp. 170–177, 1924.)—A method has previously been described [see Abstract 1390 (1923)] for determining the intensity relationships of groups of spectral lines whose components exhibit very small wave-length differences. The present paper now considers the intensity relationships of doublets and triplets whose components have great differences in wave-lengths, *e.g.* the doublets of Pb, Cs, and the triplets of Cd and Zn. The procedure for the special energy lamp (*loc. cit.*) is detailed, while the line groups are photographed as in the previous paper (*loc. cit.*). A general relationship is deduced. H. H. Ho.

1455. *Relation between Inner Quantum Numbers and Intensities of Multiple Lines.* **H. C. Burger** and **H. B. Dorgelo.** (Zeits. f. Physik, 23. 3–4. pp. 258–266, 1924.)—In a previous publication [see preceding abstract] it was briefly indicated that a regularity occurred between the intensities of the components of multiple spectral lines, which had special significance for the quantum theory of the atomic model. The present paper discusses the data of extended work in this field, whereby certain empirical rules have been derived. It must be remembered that the measurement of intensity relationships is much more difficult than that of wave-lengths, nevertheless calculated and experimental values are in agreement without exception. The only assumption made is that by the transition of the atom from a richer to poorer energy condition, the surplus of energy is emitted as monochromatic radiation according to the Bohr frequency condition. The intensity of a spectral line is then proportional to the product of the concentration of the atom in the initial state and the probability of the change in condition. The intensity measurements deal as for triplets and a prediction is given for a quartet.

H. H. Ho.

1456. *A New Method for the Direct Measurement of the Intensity Relation of Multiple Lines.* **W. Gerlach** and **O. Brezina.** (Zeits. f. Physik, 22. 4. pp. 215–221, 1924.)—The method consists in the application of the idea that the one half of the light due to neighbouring spectral lines may be reduced in brightness by a measurable amount until having the same brightness as the weaker line. The difficulty is evidently the control of the weakening and an arrangement is described consisting essentially of two crossed nicols arranged between the source of light and the spectrograph, while between these prisms is a mica or quartz plate whose direction of vibration makes an angle of 45° with that of the nicols. The latter are crossed and from the plate a smaller disc of about 1 mm. diameter is cut and mounted in a rotating sector so that it may move relative to the rest of the plate. The two plates are illuminated on one side by the source of light *via* one nicol and it is arranged that the middle plate falls as accurately as possible in the middle of the spectrum. If the direction of vibration is the same in both parts of the plate the spectrum appears uniformly bright, while if the small plate is rotated the brightness of the centre portion varies. The method is as follows. The nicols are crossed without inserting the plate, the latter being then introduced and arranged so as to give complete darkness in the field of view, and by rotating the whole plate through 45° a null position is obtained in which the lines are uniformly bright throughout their length. One then rotates the small plate until the brightness of the weakened stronger component is the same as that of the unweakened weaker component measuring the angle of rotation.

The method is discussed theoretically and it is shown that the intensity relation is independent of the reflection losses and phase changes and depends only on the angle between the axis of the smaller plate and the direction of vibration of the light. The method is very convenient photographically since the results may be made independent of the properties of the plate. It has been tested in the case of the D_1 and D_2 lines of Na known to have a relation 1 : 2, and may be applied to the determination of the relative intensities of components in the Zeeman effect and alteration of intensities of neighbouring lines under various conditions. W. V. M.

1457. *The Excitation of Spectral Lines by Electronic Collision.* I. **G. Hertz.** (Zeits. f. Physik, 22. 1–2. pp. 18–26, 1924.)—From the quantum theory it is to be expected that an atom by collision with an electron can only be made to emit such spectral lines as have a "work of excitation" less than the kinetic energy of the electron. The potential through which the free electron must fall in order to acquire this kinetic energy is the "excitation potential" of the line. In the simplest case of a Planck oscillator the excitation potential is determined by the frequency and given by $eV = h\nu$, but for a Bohr atom the "work of excitation" is given by the work required to carry the atom from its normal state into the higher of the two stationary states responsible for the emission of the line. Here $eV = Je - hT$, where J is the ionisation potential and T represents the smaller of the two terms. Observations were therefore necessary on the energy values of higher series terms. The observed energy quanta agree well with those to be anticipated on Bohr's theory.

The method used is essentially as follows. The electrons emitted from a heated kathode are accelerated by an electric field and enter a closed, and hence field free, space through a wire netting in which space they collide with the atoms of the gas or metallic vapour. The spectrum is observed in relation to the electronic acceleration. Sources of error are: (1) Potential difference between various points of the electron source (fall of potential in the heated wire). (2) Wide lattices in place of a fine wire net. (3) Disturbance due to space charge in the observation chamber [attendant upon too large current-density]. (4) The tendency of the pure electronic discharge to pass over into an arc discharge. These errors are not independent. A good experimental arrangement is described using a platinum foil as source ½ mm. away from a very fine grid, the maximum current-density being less than 10^{-4} amps. In order to avoid space charge troubles the rare gases used by the author are mixed with a gas or metallic vapour having an ionisation potential less than the first excitation potential of the substance investigated.

Photographs are given showing the spectra obtained from Hg, He, and Ne with various accelerating potentials.

For *mercury* the interesting line is 3650 which, for 9·7 volts, is the strongest line, but absent at 8·7 volts.

For *neon* instructive series of results from 18·7–20·0 volts are given showing the development of a group of red lines with increasing accelerating potentials, and similarly spectra of He show the change with increasing voltage. Zn and Th have been similarly experimented upon. For Zn by a suitable choice of potential the appearance of the triplet 4680, 4722, 4811 is demonstrated, while the strong red line 6362 first appears—as it should according to Bohr—at a potential 1 volt higher.

For *thallium* the green lines appear at 3·5 volts, and hence the normal state of the atom must be the $2p_2$ state, as shown by Grotrian from absorption measurements. W. V. M.

1458. *Broadening of Spectral Lines. Part II.* **J. Holtsmark.** (Phys. Zeits. 25. pp. 73–84, Feb. 15, 1924.)—The formulæ previously obtained [Abstract 753 (1919)] for the probability function of the molecular electric field in a dipole gas have been recalculated, taking into account the finite diameter of the gas molecule. The broadening of the hydrogen lines due to hydrogen pressure has been redetermined and compared with Michelson's results. The agreement is satisfactory if Debye's value for the quadrupole constant of the hydrogen molecule is used. The broadening of lines in the electric arc is also discussed. Comparison of the experimental results of L. W. Taylor [Abstract 323 (1923)] for the broadening of helium lines with theory gives qualitative agreement, quantitative comparison not being possible while the magnitudes of the ionic fields remain unknown [see Abstract 1167 (1922)]. A. W.

1459. *Spectral Series of Divalent Elements.* **R. T. Birge.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 233–243, Feb., 1924.)—In the second column of the periodic table the divalent elements there have two types of arc series, singlet series and triplet series. In the sixth column, oxygen, sulphur, and selenium have triplet series, while oxygen has singlet series as well, which may, however, be narrow triplets in reality.

The new series of triplets found by Hopfield [Abstract 525 (1924)] in oxygen and sulphur lead to the establishment of a triple energy level for these elements. This level is now deduced as the O*p*, or valence, level. The diagrams of Brackett and Birge suggest that deviations from Rydberg's formula in the same type of sequence of related elements are connected, and show a two-fold regularity. These regularities make it possible to predict from the diagrams the approximate value of hitherto unknown spectral terms; *e.g.* five sulphur levels are predicted, and Hopfield has found three of these, agreeing within the experimental error in magnitude. Owing to one component of Hopfield's triplets being missing, it is possible to assign the inner quantum numbers; this is the same as Sommerfeld's assignment for chromium—single S-term, triple P-term, and five-fold D-term; and it identifies the triple valence level as OP instead of O*p*.

The "singlet" series of oxygen is therefore probably narrow triplets.

An unassigned narrow triplet in sulphur and in selenium has been identified as 1S–2P, one of the members of the new triplet series.

An empirical method for extrapolating the curves of the diagrams leads to the conclusion that the missing O*s* level of the triplet diagram for the Ca and Zn groups is to be identified numerically with the 1S valence level of the singlet diagram. The two levels have different inner quantum numbers.

It is concluded that any given quantum orbit can exist in two possible states as a virtual orbit or an X-ray orbit, but in only one possible state as a valence orbit. Beryllium does not fit in very well with the diagrams.

A. C. M.

1460. *The Doublet Separation of the Balmer Lines.* **G. M. Shrum.** (Roy. Soc., Proc. 105. pp. 259–270, March 1, 1924.)—The amount of the doublet separation and nature of the fine structure of the Balmer lines to be expected on Sommerfeld's theory are discussed, together with the values for the doublet separation obtained by previous workers. A triple-walled quartz discharge tube, 50 cm. long, was used, the inner jacket being for liquid air while the outer one was evacuated. The tube was excited by a 100,000-volt X-ray transformer. During the operation of the tube, a Hilger constant-deviation spectrograph was used to record, photographically, the purity of the gas and the relative intensities of the Balmer and secondary spectra. The light from the other end of the tube was examined by means of a Lummer plate 13 cm. long and 0·448 cm. thick. Special methods of running the tube were devised in order to reduce as much as possible the secondary spectrum, and photographs are reproduced showing the separation of the first five Balmer lines. Even with the tube cooled with liquid hydrogen, no evidence of any fine structure was noted. The doublet separations measured for the first five lines are found to be in exact agreement with Sommerfeld's value.

F. S.

1461. *Series Spectra of Oxygen in the Region* λ900–λ1400. **J. J. Hopfield.** (Astrophys. J. 59. pp. 114–124, March, 1924.)—A 50-cm. focus vacuum spectrograph and special non-contrast ultra-violet photographic films were used. The mounting was such as to admit five orders of λ1000 in sharp focus on the films. The discharge tube was II-shape with a total length of one meter, the horizontal portion facing the slit, The gas pressure in the discharge tube and in the receiver was controlled by a capillary needle valve of glass. In addition there was a plate-glass condenser, a 6600-volt, 5-kw. transformer, and the necessary pumps.

New series of triplets of constant frequency difference, due to oxygen, have been found in the extreme ultra-violet. The members of these series are formed according to the combination principle by the transitions of the electron from the previously known levels of oxygen, 1*s*, 1S, 2S, . . . , 7S, 2D, 3D, . . . , 7D, to a new triple level OP_{123}. The term values of this triple level are 109607, 109674, and 109833 frequency units, respectively. This triple level is closer to the nucleus of the oxygen atom than any previously found for this element and is probably the *valence level*. In this last respect it corroborates the new Bohr theory for oxygen. Since this triple level is the valence level, it suggests the existence of three forms of atomic oxygen, two of these forms being metastable. The *resonance and ionising potentials* of the stable form of atomic oxygen, as calculated from the data of these series, are 9·106 and 13·56 volts, respectively. AUTHOR.

1462. *The Isotope Effect as a Means of Identifying the Emitters of Band Spectra: Application to the Bands of the Metal Hydrides.* **R. S. Mulliken.** (Nature, 113. pp. 489–490, April 5, 1924.)—Certain systems of bands obtained in Zn, Cd, and Hg vapours are considered by Kratzer [see Abstract 2413 (1923)], on account of the large spacing of the structure lines and the corresponding small moments of inertia, to be very probably due to hydrides of the respective elements. The same conclusion has been indicated in the case of copper by Frerichs, who has recently measured the lines of several copper bands of this type under high dispersion. A consideration of the magnitude of the isotope effects predicted by the quantum theory of band spectra for hydrides, as compared with oxides or other compounds, permits a definite decision in favour of the hydride origin of the above bands, and the trustworthiness of this theory for the electronic bands has been tested by the writer on the BO and the SiN bands. In the case of the BO bands it was the magnitude of the observed isotope effect which first definitely indicated that they were not due to BN, as formerly supposed. From numerical data quoted in the paper, the definite establishment of CuH as the emitter of the Cu bands makes it extremely probable that the similar bands of Ag, Au, and Al are also due to hydrides. Mg and Ca hydrides are well known as emitters of band spectra, and other metals give bands of large spacing likewise probably due to hydrides, which latter appear to constitute an important group of emitters of band spectra. It seems probable that most of the bands of small line spacing given by metals are oxide (perhaps sometimes nitride) bands. H. H. Ho.

1463. *Arc and Spectra Spark in the Extreme Ultra-Violet.* **R. O. Hutchinson.** (Astrophys. J. 58. pp. 280–293, Dec., 1923.)—A vacuum spectrograph was used with a concave grating with 480 lines per mm. and radius of curvature of 83·9 cm., giving a dispersion of about 24·7 Å. per mm. This grating was ruled with a very light touch, and had a bright first-order spectrum with no observable second order. Hilger-Schumann films on celluloid, 1″ × 5½″, covering the range from the central image to λ3000 were used. To entirely fill the grating it was found necessary to place the arc about 3 mm. from the slit, but the spark had to be at about three times this distance to prevent damage to the slit itself. An electromagnetic arrangement was devised for striking the arc. An intermittent exposure was always given with the arc on account of the gas liberated. The usual exposure required from fifteen to thirty minutes with current strength of from three to five amperes. For the spark the "hot spark" described by Millikan and Sawyer was used, from two to five hours being required for an exposure. Tables of wavelengths are given for aluminium, carbon, and zinc. No appreciable difference between the values for arc and spark lines was found, but relative intensities varied considerably. F. S.

1464. *Width of Absorption Lines in a Rarefied Gas.* **J. Q. Stewart.** (Astrophys. J. 59. pp. 30–36, Jan., 1924.)—The production of Fraunhofer lines by a cool rarefied gas traversed by "white" radiation is discussed from the standpoint of classical electromagnetic theory. If the gas pressure is sufficiently low, dark lines are produced by scattering, so that the term "absorption line" is a misnomer. Two causes of the widening of lines are discussed—thermal Doppler effect, and an increase in the number of active molecules in the line of sight. The latter is by far the more effective. Equations are developed for *line-width* and for the minimum number of active molecules required to produce a just visible line. The theory is applied to the solar spectrum and attention is drawn to the smallness of the number of molecules required to produce a line. Thus the number of sodium atoms effective in producing the D lines in the solar spectrum is calculated as 3×10^{16} per sq. cm. This indicates a very low density of gas in the solar reversing layer. The calculated weight of sodium per sq. cm. column of the reversing layer is, however, considerably greater than the weight which selective radiation pressure would support. J. J. S.

1465. *Ultra-Violet Absorption Spectra.* **W. Gross.** (Zeits. Electrochem. 30. pp. 18–20, Jan., 1924.)—An extinction-curve method is described for observing ultra violet absorption-spectra, suitable for use with dilute solutions, and here applied to different salts of copper. A. C. M.

1466. *Extreme Ultra-Violet Spectra.* **R. A. Millikan** and **I. S. Bowen.** (Phys. Rev. 23. pp. 1–34, Jan., 1924.)—A vacuum apparatus and explosive spark were employed to investigate the regions between 136 Å.U. and 1862 Å.U. for a great variety of electrodes. The lines thus obtained were assigned to the elements by a process of elimination, considering the different combinations of elements present in the electrodes employed. Thus, as an example, between 1000 Å.U. and 330 Å.U., chemically pure Mg and Al gave practically identical spectra, while on the same plates the lines above 1300 Å.U. were different and belonged to the metals. This meant that the lines below 1000 Å.U. were the nearly pure spectrum of the oxygen atom, as this could have been the only impurity of importance present. The only impurities probably present in the carbon employed were oxygen and aluminium, so by subtracting the O and Al lines, the carbon lines remained; and so on. Where doubtfulness arose, lines were listed under both elements, the degree of uncertainty being indicated by subscript numbers:

Hydrogen. Two lines only, both belonging to the Lyman series.

Helium and lithium. No lines.

Beryllium. One doubtful line.

Sodium. One strong line, 372·3 and one doubtful one, 376·6.

B, C, N, O, F, Mg, Al, Si, P, S, Cl, K, Ca, Cr, and Cu from 9 to 160 lines each, listed in tables.

The strongest lines for each of the elements are L-series lines, and they form a progression similar to Moseley's for the X-ray spectra. They are mainly doublets, the separation increasing regularly with atomic number. M spectra were also investigated, and they were of shorter wave-length the higher the atomic number, but identification was less easy. Two diffuse series lines and 2 sharp series lines observed belong to Mg(II), 5 lines due to Al^{+}, and 9 due to Al^{++} or Al(III), 11 lines due to Si(IV), and probably the first terms of the principal series and of the diffuse series of P(V). The Bohr theory has been applied to the results obtained, and give values of the L and M levels of the atoms as follows: *Sodium,* L(I), $\nu/R = 2 \cdot 826$. *Magnesium,* L(I) 4·298, L(II) 3·402, L(III) 3·381. *Aluminium,* L(I) 6·045, L(II)–L(III) 5·008. The square roots of these values are linear functions of the atomic numbers.

For Ca M(II), $\nu/R = 1 \cdot 839$, M(III) 1·810. The difference L(II)–L(III) for Mg, gives a screening constant 3·1; the difference M(III)–M(II) gives for Ca the constant 7. All these results agree well with other data.

Using as source exploded electrodes in a vacuum, the strongest spectrum lines emitted are due to "stripped" atoms; *i.e.* atoms which have been denuded of all valence electrons; for example, Na(I), Mg(II), Al(III), etc. A. C. M.

1467. *The 3883 Cyanogen Band in the Solar Spectrum.* **R. T. Birge.** (Astrophys. J. 29. pp. 45–60, Jan., 1924.)—A critical study of the 3883 band has yielded a list of 189 lines, apparently not blended, and suitable for investigation of the Einstein shift. Spectrograms from the Mount Wilson Observatory and numerous enlargements were used. A recomputation of previous work on the Einstein shift by St. John, Grebe, and Bachem leads to the original results, so that the disagreement between the results of these investigators still remains. The relative wave-lengths of the 189 chosen lines in the arc and in the sun have been measured on a plate of 2·5 mm. per Ångström dispersion, and are found to be the same within limits of error. Many previously measured discrepancies are found to be due to the use of undetected blends. The present result indicates that any solar shift, if present, is common to all the lines of this band. In a table, in addition to the 189 lines, are given 135 other lines in the region λ3881 to λ3773. F. S.

1468. *Absorption Spectra of Dyes in Different Concentrations.* **W. C. Holmes.** (Indust. and Engin. Chem. 16. pp. 35–40, Jan., 1924.)—A summary of the variation in absorption of over 100 dyes due to changes of concentration over a wide range. A Hilger wave-length spectrometer and Nutting photometer were used. Apart from symmetrical modifications of the absorption bands, displacements of the maxima and appreciable modifications of the form of the absorption curves were observed, often of a radical order. For example, a majority of the azo-dyes examined behaved in this way. Pontachrome Violet SW and Diamine Black BO are exceptions to a general rule that with increasing dilution the maxima shift towards the red end. Further, the majority of the triamino derivatives of triphenylmethane and diphenylnapthylmethane are also much affected. The only exception in point of direction of shift was Alkali Blue 6B.

Numerous instances are cited of the connection between chemical constitution and behaviour on dilution, and it is concluded that the phenomena must be due to constitutional alteration. Change in absorption must imply change in constitution, and in many cases the effect is so great that a radical change is indicated. Tautomerism between widely separated absorption bands in the cases of Crystal Violet and Methylene Blue is evidence that these dyes exist in aqueous solution in a state of tautomerism between two constitutional forms, and that as the solution is varied, molecular rearrangement occurs. It is regarded that change in concentration, of itself, is insufficient to explain the phenomena; also that hydrolytic dissociation, electrolytic dissociation and solvation are inadequate. The effect of molecular aggregation may be important; but it is concluded that change in colloidal state may directly affect the molecular tautomerism. A. C. M.

1469. *Near Infra-Red Absorption Spectra of some Organic Liquids.* **J. W. Ellis.** (Phys. Rev. 23. pp. 48–62, Jan., 1924.)—Using a spectrograph with rather dense flint-glass prisms many organic compounds have been studied whose infra-red absorption spectra have heretofore been examined, if at all, only with the use of rock-salt prisms, and thus many absorption bands have been obtained which could not be resolved with such prisms. The self-recording prism spectrograph Littrow mounting, with dispersion equivalent to two 60° flint-glass prisms, was arranged so that the spot of light from the mirror of the galvanometer in the thermopile circuit was focused on a sheet of bromide paper on a drum rotated in gear with the prism table. Curves obtained show the transmission through 11 mm. of the following organic liquids: Ethyl, methyl, propyl, butyl, ethylene, and methylene halides, butyl nitrite, benzene, toluene, pentane, hexane, heptane, octane, mesitylene, paraxylene, chloroform, and bromoform. In a table are given the wave-lengths of the absorption maxima, and in many cases the percentage absorption. Curves obtained by visual observations are also given for eight of the above compounds and for acetone and ethyl ether. Bands near 0·90, 1·02, 1·17, 1·38, and 1·70 μ occur in most of these spectra. Hence these bands are attributed to the C—H bond. They appear to be harmonics of a fundamental frequency found by Coblentz at 6·9 μ. There are also bands at 1·81, 1·91, 2·00, and 2·10 μ which occur for several liquids. Some of the bands are double, like the infra-red bands due to gaseous compounds. The simple quantum theory of such gaseous spectra does not seem to hold directly for the liquid spectra since the separation of the components of 1·38 μ and also of 1·7 μ is greater for the iodides than for the corresponding chlorides. J. J. S.

1470. *Harmonic Frequency Relations in the Infra-Red Absorption Spectra of Liquids and Solids.* **J. W. Ellis.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 1–9, Jan., 1924.)—Observations of infra-red absorption spectra of a number of substances, both organic and inorganic, are described and discussed in conjunction with the results obtained by other observers, and it is concluded that a pair of atoms held in chemical union, such as C and H, O and H, etc., even though forming a part of a more complex molecule, has not only a fundamental period of vibration to which it responds when an electromagnetic wave of that frequency strikes it, but that it will also respond to whole multiples, or approximately whole multiples, of that frequency under the proper stimulus. A. B. C. L.

1471. *Higher-Order Spectra of Argon, Krypton, and Xenon.* **L.** and **E. Bloch** and **G. Déjardin.** (Comptes Rendus, 178. pp. 766–769, Feb. 25, 1924.)—Continuation of previous work. The spectra were recorded which were emitted successively at the periphery of the glow excited in these gases, by an electrodeless discharge, as the voltage was increased. The gases showed neither water-vapour nor mercury-vapour as impurity when examined spectroscopically; also the krypton and xenon were free from each other. The oscillatory discharge was found to drive the gases (particularly argon) into the wall of the quartz vessel; the tube could be softened by roasting.

Fifteen wave-lengths are given for each gas, grouped in 3 sets of five belonging to the 1st spark, 2nd spark, and 3rd spark respectively. For all three gases, the 1st-spark spectrum extends from the extreme red to the extreme violet. The 2nd-spark spectrum, much less rich in lines, commences sharply at the border of the violet and ultra-violet. The 3rd-spark spectrum has many more lines in the ultra-violet than in the visible region. More detailed results are to appear later. A. C. M.

1472. *The Vacuum Spark Spectrum of Calcium.* **J. A. Anderson.** (Astrophys. J. 59. pp. 76–96, March, 1924.)—Calcium electrodes 6 millimetres in diameter with a gap of 2 millimetres were used in a glass vacuum chamber. Vacuum sparks were produced by the discharge of a 1·0-microfarad condenser charged to a potential of 20,000 volts. The spectrum was photographed with a 1-metre focus, 4-inch concave grating, and the longest exposure required was 400 sparks. The probable error of the wave-length of good lines is about ± 0·02 Å. The chief impurities were Mg, Sr, O, and N. A table contains 850 lines which are ascribed to calcium, and in a second table are collected 46 of these, which represent all the lines observed which have previously been listed as calcium lines. It is likely that many of the new lines are due to Ca^{++}.

Specification of Spark Circuits.—It is suggested that spark circuits should be specified by the maximum value of the current, the maximum value of the potential difference between the terminals, and the frequency of oscillation, or by data from which these quantities may be readily obtained. The subject is discussed briefly and a few numerical examples are given. In the present investigation the maximum value of the current was about 10,000 amperes, the maximum potential difference 20,000 volts, and the frequency 87,000 cycles.

Intensity Scale for Spectra.—An attempt is made to give intensities of lines on a logarithmic scale to base 2, that is, a line of intensity m is 2^n times as bright as a line of intensity $m-n$. The method of exposure ratios is employed.

Direct Wave-Length Reader for Grating Spectra.—A revolution counter provided with a small circle to read fractions of a revolution is geared to the head of the measuring machine, the gear ratio being so chosen that one revolution of the counter circle shall be very nearly equal to 1 Å. on the plate. Approximate wave-lengths can thus be read directly. Corrections are derived from similar readings on the comparison iron arc spectrum, and, as they are small, they are very easy to apply. Tests show no appreciable loss in accuracy and a very great saving in the time required to measure and reduce a spectrogram. AUTHOR.

1473. *Series Spectrum of Ionised Carbon (CII).* **A. Fowler.** (Roy. Soc., Proc. 105. pp. 299–310, March 1, 1924.)—The system of series dealt with is characterised by a fourfold value of the hydrogen constant and attributed to singly ionised carbon. The sources used include the spark between graphite poles in air, the spark in hydrogen, the arc *in vacuo*, and carbon compounds in vacuum tubes. The vacuum tube spectra gave lines of fine definition, while the spark lines in the ultra-violet were mostly diffuse. Several lines had been previously recorded, but in few cases were the wave-lengths sufficiently accurate. New lines include a pair in the extreme red and three pairs in the ultra-violet. The spectrographs used include a 10-foot concave grating, two large glass spectrographs, a quartz Littrow spectrograph, another quartz spectrograph, and a vacuum grating spectrograph. Simeon's wave-lengths in the extreme ultra-violet were adopted. Tables are given of the lines comprising the spectrum of CII, of these lines arranged in series, of the series terms and effective quantum numbers. The value 196670 for the highest limit of CII corresponds to a second ionisation potential of 24·28 volts. F. S.

1474. *Absorption Spectra of Chromium and Iron Vapours.* **H. Gieseler and W. Grotrian.** (Zeits. f. Physik, 22. 4. pp. 245–260, 1924.)—The work is a continuation of that by one of the authors [see Abstract 907 (1923)] upon various metallic vapours, and in the course of which no results were obtained with chromium and iron. The difficulty of obtaining sufficient vapour pressure with the elements to give absorption lines was overcome by heating in an evacuated quartz tube of about 30 cm. length to 1250°. The absorption was detected by the method lately developed by Madelung and Götze [see Abstract 2151 (1923)] and by Schütz. The quartz spectrograph previously used was employed and also a grating spectrograph with a Rowland grating of 1·50 m. radius and 14,438 lines per inch on an Eagle mounting. In the case of chromium, two groups of lines, 4289·92, 4275·01, 4254·52, and 3605·49, 3593·64, 3578·81 Å., were found, and eleven lines in the case of iron, these belonging to the multiplets found by Walters in the iron arc spectrum. The quantum relations of these lines are discussed with reference to their Zeeman effect and Landé's theory. F. S.

1475. *The Arc Spectrum of Chromium.* **H. Gieseler.** (Zeits. f. Physik, 22. 4. pp. 228–244, 1924.)—Catalan first obtained some characteristic groups of chromium, and the author [Abstract 1141 (1923)], on the grounds of the Zeeman effect, coordinated a few lines. Catalan has in further work calculated the ionisation potential and the values of certain terms. The author has come to very similar conclusions to those of Catalan, but more series terms have been examined and also the Zeeman effect of some groups. The paper is almost entirely a compilation of data and should be consulted. W. V. M.

1476. *The Spectrum of Fluorine.* **H. G. Gale and G. S. Monk.** (Astrophys. J. 59. pp. 125–132, March, 1924.)—*The line spectrum,* from λ7800 to λ3400, has been photographed with a 21-foot concave grating and the wave-lengths measured. Spectra have been taken from a spark between gold electrodes in fluorine at atmospheric pressure and from vacuum tubes at reduced pressures.

The band spectrum has been photographed, and the approximate wave-lengths of the heads of ten bands between λ7000 and λ5100 have been measured. AUTHORS.

1477. *The Spectrum of Neutral Helium. Part II.* **C. V. Raman and A. S. Ganesan.** (Astrophys. J. 59. pp. 61–63, Jan., 1924.)—In his rejoinder to the above authors' criticism [see Abstracts 1857 and 1858 (1923)] of his paper [see Abstract 161 (1923)] on this subject, Silberstein has attempted to dispose of their contention that the approximate coincidences between some of the lines of the helium spectrum and those given by his combination formula are purely fortuitous. The two points raised by Silberstein are now answered. For this purpose the figures have been recalculated, taking the maximum limit of the quantum numbers to be that proposed by Silberstein. The number of fortuitous coincidences to be expected between the observed lines of the helium spectrum and those given by the formula is calculated, and found to agree fairly well with the actual number. The view that the coincidences noticed are due to mere chance is maintained. H. H. Ho.

1478. *Fine-Structure of Hydrogen, Ionised Helium, and X-Rays.* **E. Lau.** (Phys. Zeits. 25. pp. 60–68, Feb. 1, 1924. From the Reichsanstalt.)—A general review is given of work on fine structure, with special reference to the possible errors. Of measurements on the Balmer lines previous to those of Gehrcke and the author, the interferometer measurements have special importance, as they are most free from errors. The mean value for all the determinations for the doublet separation of $H\alpha$ is 0·298 cm.$^{-1}$ (interferometer observations only), while Sommerfeld's theory requires 0·365 cm.$^{-1}$. Since the error due to superposition of neighbouring components is absent, the number thus obtained should be weighted above other values got by other methods.

More recent determinations with the Lummer-Gehrcke plate, and with the grating, etc., are subject to physiological and photographic errors, which may produce an apparent increase of $\nabla\nu_{\mathrm{H}}$ by as much as 40 %. Gehrcke and Lau have made a redetermination of this quantity, using a Lummer-Gehrcke plate, and after allowing for various errors, obtain 0·293, in good agreement with the early interferometer results. Further, attention is drawn to the lack of agreement between Sommerfeld's theory and the anomalous Zeeman effect observed in the Balmer lines [see Abstract 530 (1924)].

Values based on observation of ionised helium lines are even less satisfactory; λ4686 alone gives a value of $\nabla\nu_{\mathrm{H}}$ consistent with Sommerfeld's theory, and in this case, the spark photographs give so many lines in the neighbourhood of the group, that an unequivocal choice is impossible. For the rest, the value of $\nabla\nu_{\mathrm{H}}$ is smaller than expected. The separations of X-ray doublets are also considered, but can be shown to be as consistent with the value 0·298 as with 0·365. A. C. M.

1479. *Absorption Bands of HCl.* **W. F. Colby.** (Astrophys. J. 58. pp. 303–306, Dec., 1923.)—The two absorption-bands of HCl are refermulated in terms of half-parameter numbers; the new molecular constants thus calculated, and the band is predicted corresponding to a vibrational quantum change 1 → 2. This is in agreement with a faint band recently found, which would otherwise be difficult to account for. Apart from this, the new formulation leads to nothing new or decisive. A. C. M.

1480. *Regularities in the Arc Spectrum of Iron.* **F. M. Walters, Jr.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 245–274, Feb., 1924.)—Of the metals of the eighth group, iron appears best suited for the study of spectral regularities. Although its spectrum is complex, the wave-lengths of many lines have been measured to high accuracy in a wide spectral range. Moreover, the behaviour of many of its lines in the magnetic field and under pressure has been observed, and a fairly complete temperature classification made from furnace spectra. The wave-lengths used have been taken from the work of Burns, supplemented in the ultra-violet by those of Schumacher and in the infra-red by those of Meggers and Kiess. Twenty-two polyfold levels have been found, the inter-combinations of which result in fifty-four or more multiplets, which are given in a table. From the inner quantum numbers and Landé's scheme for the Zeeman effect, the identification of several of these polyfold levels as P, D, and F terms has been made. For iron it has been observed that a correlation exists between lines grouped in a multiplet and their behaviour under pressure, as well as the behaviour in the electric furnace. F. S.

1481. *The Structure of the Iron Spectrum.* **O. Laporte.** (Zeits. f. Physik, 23. 3–4. pp. 135–175, 1924.)—In this paper 30 multiplets are described in the arc spectrum of iron, 10 of these having been discovered subsequent to those by Walters [see Abstract 91 (1924)]. The theoretical significance from the quantum standpoint is that in the iron spectrum terms of the quintet and triplet systems occur, and, as in the case of vanadium, widely separated Überbergmann terms have been established. Support is afforded to the theoretical argument by the Zeeman effects. In agreement with the absorption experiments of v. Angerer and Joos [Naturwissenschaften, 12. 140, 1924], a *d-term* of the quintet system is found to be the fundamental term of the iron spectrum. Two kinds of terms which belong presumably to different states of the atom and have been established for the alkaline earths are found completely represented in the iron spectrum. The gap in the Rydberg series formula prevents for the present an exact determination of the term magnitudes. The approximate value of the ionisation potential is 5·9 ± 0·1 volts, but the first line (λ3859·913 Å.U., ν25900·00 cm.$^{-1}$) corresponds to a potential of 3·2 volts. A very comprehensive table is included containing all the strong lines of the iron spectrum, a total of 321 lines being classified and corresponding to about 15 % of the total number of iron lines. A supplementary note points out combinations of septet terms in two multiplets and a further relationship among the triplets. H. H. Ho.

1482. *Analysis of a Component of Mercury Radiation* 5461 Å. **Rita Brunetti.** (Acad. Lincei, Atti, 32. ii. pp. 496–499, Dec. 16, 1923.)—In time or with forcing the lamp, this component undergoes changes, *per saltum*, of a quantic order. A. D.

1483. *Absorption of Potassium Vapour at High Temperatures.* **A. L. Narayan and D. Gunnayya.** (Phys. Rev. 23. pp. 46–47, Jan., 1924.)—

Further experiments have confirmed the existence of the lines λ5340, 5300, 5205, 5100, 4970, and 4831 previously noticed. The line 4831, well defined and coming next to 4641 and 4642 in intensity, is probably the combination line (1P-8D). The line 4120 was observed distinctly reversed. The absorption spectrum showed about 15 satellites accompanying P_3 to P_8 which are not found in the emission spectrum. They increase in number and in width with increase of vapour density, finally coalescing to form a wide band. J. J. S.

1484. *The Electric Furnace Spectrum of Titanium in the Ultra-Violet.* **A. S. King.** (Mt. Wilson Observat. Contrib. No. 274. Astrophys. J. 59. pp. 155–176, April, 1924.)—This paper supplements "Mount Wilson Contribution," No. 76, published in 1914 [see Abstract 1415 (1914)] which covered the region λ3888 to λ7364. Temperature stages of 2000°, 2250°, and 2600° C. were employed to observe the initial appearance and rate of increase in intensity of the ultra-violet lines. The spectrograms were made in the first and second orders of a 15-foot concave grating. A table gives the temperature classification of 785 lines, and their relative intensities in the arc and at the three furnace temperatures. New wave-lengths are given for 333 furnace lines which have not been measured in the arc spectrum, or for which the arc values are poor, owing to diffuseness or blends. Many of the new wave-lengths are for lines which are very weak in the arc. Comparison photographs of the spark spectrum were made for the selection of enhanced lines, which in this region are found to appear at lower temperature than the enhanced lines in the visible spectrum. The classification thus includes many lines of the ionised atom, and note is made of phenomena of reversal and dissymmetry in the condensed spark. A mixture of titanium with potassium had the effect of suppressing the enhanced lines of titanium, as has been noted in other cases of mixture with elements of lower ionising potential. AUTHOR.

1485. *Oscillographic Study of the Production of X-Rays by a Coolidge Tube.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 22. pp. 70–75, Feb., 1924.)—For a complete understanding of the working of an X-ray apparatus it is necessary to know the instantaneous values of (*a*) the potential applied to the tube, (*b*) the current passing through it, (*c*) the quality and (*d*) the quantity of the X-radiation emitted. In the present experiments the author has attempted to obtain a simultaneous record of all four factors on the same plate, under the normal working conditions of an X-ray plant. The records of the potential variations applied to the tube were obtained by means of the electrostatic oscillograph described in another paper [Abstract 1575 (1924)]. The current record was given by an oscillograph of the Duddell type. The intensity of the X-ray beam passing through a slit was determined by the blackening of the photographic film. As a rough measure of penetrating power of the rays, an aluminium wedge was fixed across the middle of the slit. Some estimate could thus be made of the quality of the radiation at different points during discharge.

The excellent records obtained bring out many very important points relating to the efficient use of X-ray tubes. It is shown that a spark-gap cannot be used to estimate the quality of the rays when a Coolidge tube is used with unrectified current. One record shows that the width of the X-ray band is considerably less than that of the current wave—corresponding in fact to the period during which the potential curve is greater than 30 kilovolts. A considerable portion of the current through the tube is thus wasted from a practical point of view. With an induction coil the potential rises almost instantaneously to its maximum value and the X-rays are emitted in a series of very narrow bands. On account of the narrowness of these bands in comparison with those when a transformer is used, the energy output with an induction coil is relatively small. It is shown that the average current through a tube affords no measure of the intensity of the X-radiation; an observation in agreement with that of A. E. Owen [Abstract 1638 (1924)]. A. B. W.

1486. *Refraction of X-Rays in Pyrites.* **B. Davis.** and **R. v. Nardroff.** (Nat. Acad. Sci., Proc. 10. pp. 60–63, Feb., 1924.)—Using an X-ray tube with water-cooled molybdenum target, and a specially constructed ionisation spectrometer, the authors have made a careful series of observations of the X-ray reflection from pyrites. From the observations the value of δ (where $\mu = 1 - \delta$) is determined and compared with the values deduced theoretically from Stenström's relation [see "Untersuchunger der Röntgenspektron," Dissertation, Lund, 1919] and from Lorentz's dispersion formula for ordinary light.

λ.	δ (Experimental).	δ (Calculated) (Lorentz).
0·6311	$2{\cdot}82 \times 10^{-6}$	$2{\cdot}62 \times 10^{-6}$
0·7078	$3{\cdot}33 \times 10^{-6}$	$3{\cdot}29 \times 10^{-6}$

The agreement between the experimental results and theory is important and suggestive. A. B. W.

1487. *Change of Wave-Length by Scattering in the Case of the K-Radiation of Tungsten.* **M. de Broglie.** (Comptes Rendus, 178. p. 908, March 10, 1924.)—The note refers to an experiment to test Compton's theory of change of wave-length of X-rays when scattered by different elements. The author uses *k*-rays of tungsten and a compound scattering surface of powdered metallic tungsten and carbon. The photographic plate registers at the same time the fluorescent *k*-radiation from the tungsten powder, and the scattered radiation (due to the presence of the carbon). The records show two lines well separated and corresponding to the first order of approximation to the values predicted by Compton's theory. A. B. W.

1488. *Scattering of X-Rays and Bragg's Law.* **G. E. M. Jauncey.** (Nat. Acad. Sci., Proc. 10. pp. 57–60, Feb., 1924.)—In 1914 Darwin showed that when the classical electromagnetic theory of light is applied to the regular reflection of X-rays by a crystal a small departure from Bragg's law is demanded if there is a refractive index for X-rays in the crystal. The theory further demands that the refractive index shall be $1 - \mu$, where μ is a small positive quantity. Recently Compton published a paper on scattering of X-rays and which he showed that a change of wave-length is to be expected on scattering of X-rays. The writer now suggests that if crystalline reflection of X-rays is a special case of scattering, then the reflected ray should be of longer wave-length than the incident ray [see also " Nature," 112. p. 325, 1923]. On examination of experimental data in this light it is found that the experimental deviations from Bragg's law cannot be explained on the assumption of a change of wave-length on reflection. The author therefore arrives at the conclusion that Darwin's theory of a refractive index is more probably the correct explanation of observed deviations from Bragg's law. [See Abstract 535 (1924).] A. B. W.

1489. *The Recoil of Electrons from Scattered X-Rays.* **A. H. Compton and J. C. Hubbard.** (Phys. Rev. 23. pp. 439–449, April, 1924.)—The theory here given is an extension of the quantum theory of scattering suggested by Compton, which assumes that each directed X-ray quantum is scattered by a single electron. Expressions for the distribution of recoil velocities, of energies and of ranges are developed for each of two postulates, assuming that (1) the scattered radiation consists of directed quanta, and (2) the scattered radiation proceeds as spherical waves. On the first postulate the maximum recoil energy is shown to be $E_m = h\nu_0 \times 2\alpha/(1 + 2\alpha)$, where $\alpha = h/mc\lambda_0$; the recoil electrons are shown to be concentrated at angles near the direction of the primary beam; and from the distribution of energy, using a relation given by C. T. R. Wilson, the distribution of ranges is found to be such that two-thirds have tracks shorter than half the maximum range. The maximum range increases rapidly with frequency. The values for the maximum ranges in the case of X-rays (0·34 to 0·48 Å.) are computed to be about one-third of those observed by Wilson for his "fish" tracks, but the difference may be due to the lack of homogeneity of the rays used. The relative number of recoil electrons to photo-electrons increases with the frequency and is in agreement with observations by Wilson. The second postulate, however, leads to a value for E_m only one-fourth that given above, a value which is inconsistent with that derived from a consideration of radiation pressure and which leads to values for maximum ranges one-fiftieth of those observed by Wilson. Other experimental observations are cited which also lead to the conclusion that the first postulate is much more likely to be true than the second, hence, that each quantum of scattered radiation is probably emitted in a definite direction. AUTHORS.

1490. *A Necessary Consequence of the Compton Effect and its Confirmation.* **L. Meitner.** (Zeits. f. Physik, 22. 5. pp. 334–342, 1924.)—When Röntgen or γ-rays of frequency ν_0 impinge on matter, two different processes arise, *viz.* (1) A true absorption whereby the ray abstracts an electron from the impacted atom and thereby loses its entire energy quantum according to the Einstein equation for the photo-effect, $h\nu_0 = E_\beta + A$, where E_β is the kinetic energy from the electron and A is the work of detachment. If the incident wave radiation be monochromatic, then the separated electrons will possess discrete energy values depending on the respective K, L, or M rays. (2) A scattering effect shown to take place by Compton [see Abstract 2194 (1923)] under special circumstances, so that a part of the energy of the primary ray appears as energy of a deflected ray of smaller frequency ν, and another part as kinetic energy E_β of the scattered electron. The above equation then becomes $h\nu = h\nu_0 + E_\beta$. The energy of the detached electrons depends on the magnitude of the scattering angle [see Abstract 1878 (1923)], and the photo-effect is only possible if the absorbed electron is so united to the atom that the atomic residue can also receive an impulse. Practically for the same substances with decreasing wave-length of the incident rays, the photo-effect becomes more improbable and the Compton effect more probable. The two effects can be identified by the line spectrum of the former and the continuous one of the latter. The paper itself is a discussion of the work of Bragg, Compton, Debye, Augur, Cooksey, Seitz, Wilson, Kohlrausch and Schrödinger, Bothe, Ross, and of the author relevant to these effects. The conclusion is drawn that if the photo-effect be assumed symmetrical as a first approximation, the Compton effect can then be estimated for different wave-lengths and materials from the observed asymmetry. This is especially accessible for the lighter atoms and shorter wave-lengths. H. H. Ho.

1491. *Tertiary X-Radiation.* **G. L. Clark** and **W. Duane.** (Nat. Acad. Sci., Proc. 10. pp. 41–47, Jan., 1924.)—The authors have examined secondary radiators consisting of fifteen different chemical elements whose atomic numbers range from 6 (carbon) to 60 (neodymium). The radiation from the secondary radiator produced by the primary rays consists of a continuous spectrum beginning at the short wave-length limit and extending toward the longer wave-lengths. The spectrum is regarded as produced mainly by the primary continuous spectrum. Upon the secondary continuous spectrum are superposed peaks representing (*a*) the scattered radiation of the *k*-series line spectra of tungsten reflected in the first, second, and third order spectra. These peaks correspond to wave-lengths that are equal to those of the primary rays to within experimental error (0·1 %); (*b*) peaks representing the *k*-series fluorescent live spectra of the secondary radiator; the wave-lengths corresponding to these peaks equal the wave-lengths of the primary *k*-series lines of the respective chemical elements to within the limits of experimental error (0·1 %); (*c*) humps, the short wave-length limits of which correspond to their theoretical values (see original paper) and which represent tertiary radiation from electrons ejected by the primary tungsten lines. All the observed characteristics of the radiation are explained as due to the above-mentioned causes. In particular, the authors have not observed peaks which correspond to a shift of exactly 0·024 Å.U. which should occur if the incident X-ray quanta deliver their energy and momentum to single electrons according to Compton's theory. A. B. W.

1492. *Reflection by a Crystal of its Characteristic X-Radiation.* **G. L. Clark** and **W. Duane.** (Nat. Acad. Sci., Proc. 10. pp. 48–53, Jan., 1924.)—The object of the present note is to present (1) a new precision measurement of the spectrum, characteristic of iodine, reflected through 5 orders by the 100 planes of *k*I in accordance with the Bragg law, and (2) a further verification of the anomalously reflected X-rays characteristic of iodine from *k*I. See previous papers by the same authors [Abstracts 866 (1924) and 2202 (1923)]. A. B. W.

1493. *Soft X-Rays from Tungsten.* **C. B. Bazzoni** and **C. T. Chu.** (Frank. Inst., J. 197. pp. 183–197, Feb., 1924.)—This paper consists of two parts, the first part reviewing the present theory of atomic structure and giving data of the K, L, M, O, and P radiations which depend largely upon experimental data rather than theoretical results. The study of soft radiations, such as of the P and O levels, are important for the theory (Bohr), but the photo-spectrographic method is no longer applicable, and the radiations must be studied by the photoelectric method.

The second part of the paper describes an experimental arrangement which is an extension of the method of Richardson and Bazzoni [Abstract 895 (1922)] in which electrons are emitted from a tungsten filament and a condenser, when properly charged, prevents the ingress of electrons into a chamber containing a photoelectrically sensitive disc of copper, connected to a Dolezalek electrometer. Details of exhaustion and difficulty due to melting and leakage of the seals are given, with the method of operation. To standardise and check results the apparatus was first used with a molybdenum target and the experimental results found to agree with the known molybdenum radiation, in spite of the deficiencies of the present apparatus. A target of tungsten was then introduced. The experimental results are discussed, in relation to the theoretical values of Hjalmar, and it was decided that the presence of N and O radiation was proven and that, within the experimental limitations, this radiation is from the N_1, N_2, and O_{3-4}, levels, but further experiments, with improved technique, are to be carried out to confirm the latter and to measure the wave-lengths by the magnetic method. B. J. L.

1494. *Relativistic Röntgen L-Doublets and the Screening Constant.* **J. B. Green.** (Phys. Rev. 22. p. 546, Dec., 1923.)—A more accurate method of computing the screening constant shows that the conclusion in a previous paper [see Abstract 1153 (1923)] is incorrect, and that the screening constant would not be constant if terms beyond the third were neglected in accordance with Bohr's suggestion. AUTHOR.

1495. *Spectral Series in the Soft X-Ray Region.* **G. K. Rollefson.** (Phys. Rev. 23. pp. 35–45, Jan., 1924.)—It has been found that spectral lines can be detected in the soft X-ray region by studying the total photoelectric effect produced by the radiation as a function of the accelerating voltage applied to the electrons producing the radiation. This method has been used to measure the wave-lengths of nine M lines of iron between $\lambda = 264$ Å. and $\lambda = 77$ Å., and three L lines $\lambda = 20{\cdot}0$, $19{\cdot}4$, and $17{\cdot}7$ Å. These measurements show that the method is capable of filling in the gap in the spectrum between the ultra-violet and the X-ray regions. By applying the combination principle, it has been shown that the results obtained are in accord with Millikan's measurements in the extreme ultra-violet spectrum of iron and also with Siegbahn's measurements of the K-series of iron. A. B. W.

1496. *Ionisation of Gases as a Function of the Energy of Electron Impacts.* **A. L. Hughes and E. Klein.** (Phys. Rev. 23. pp. 450–463, April, 1924.)—*Ionisation up to 300 Volts.*—Electrons were accelerated from a tungsten wire to a plane perforated electrode G, through which a small fraction passed into a space where they were all stopped by a retarding field between the perforated electrode and a plane parallel plate P connected to an electrometer, which collected all the positive ions formed on collision between the electrons and the gas molecules. The fraction of the collisions resulting in ionisation as a function of the energy of impact is shown to be $f(V') = (1/2apD)[d(V_0P/E)/dV_0]$, where P/E is the ratio of positive ions produced to the number of electrons passing through the perforated electrode G, V_0 is the retarding potential between P and G and is somewhat greater than V′ the maximum energy of impact, p is the pressure, D the distance apart of P and G, and α is the chance of collision per cm. for 1 mm. pressure which is assumed to have the kinetic theory value. For *helium*, *neon*, *argon*, *hydrogen*, *nitrogen*, and *methane*, $f(V')$ was found to increase very rapidly to a maximum value, after which there was a less rapid, though marked, decrease. The maxima occur at 147, 157, 80, 74, 101, and 80 volts for the gases in the order named, the maximum values being respectively 0·11, 0·14, 0·35, 0·21, 0·32, and 0·28. Even for the most favourable velocities, then, less than half the collisions result in ionisation.

Radiation Potentials of Argon and Carbon.—A break in the argon curve suggests L radiation for argon at 250 volts impact energy, while a break in methane curve indicates a possible K radiation for carbon at 248 volts.

AUTHORS.

RADIO-ACTIVITY.

1497. *Radio-Activity.* **J. E. Underwood.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1155–1159, Dec., 1923.)—Simple apparatus for demonstrating characteristic electric, photographic, scintillating, fluorescent, and absorption effects. A. D.

1498. *Determination of Thorium Emanation in Hot Springs—Using the Method of Induced Activity.* **A. Lepape.** (Comptes Rendus, 178. pp. 931–934, March 10, 1924.)—The paper gives the results of a series of measurements of the thorium emanation content of the waters at Bagnères-de-Luchon, Vernet-les-Bains, Les Escaldes, Thuès-les-Bains, La Bourboule, Royat, St. Nectaire. The first four of these springs are in the Pyrenees, the remainder on the Central Plateau. In the former case no thorium emanation could be detected, whilst on the Central Plateau, small quantities were detected with certainty. A. B. W.

1499. *Investigation of the Air in the Schneeberg-Oberschlema Borings for the Radium Emanation Content.* **P. Ludewig** and **E. Lorenser.** (Zeits. f. Physik, 22. 3. pp. 178–185, 1924.)—The region referred to in the title is especially suitable for the study of radium emanations. Previous work there is first briefly detailed. Following this comes a full account of recent investigations by the present authors, with apparatus, details, and data in tabular form. The paper is entirely descriptive and should be read in the original. H. H. Ho.

1500. *Cosmic Origin of Radio-Active Substances in the Atmosphere.* **H. Bongards.** (Astrophys. J. 58. pp. 307–313, Dec., 1923.)—The presence of the emanations of the radio-active elements in the earth's atmosphere has generally been attributed to exhalations of the soil and the rocks. Observations by the author in 1913 at Lindenberg, by means of steel wires 5 to 15 metres in length, carried to altitudes of 4000 metres by kites, showed an unmistakable dependence of the quantity of emanation present upon the barometer at the surface and the temperature of the air strata measured. A period of 27 or 28 days in the variations observed suggested the sun as the source, since this is approximately the period of rotation of the sun. This suggestion was corroborated by a study of observations by Wright and Smith at Manilla, Philippine Islands, during the same period of time. The fluctuations were the same at the two places. The author therefore concludes that the sun is the source of the emanations and not the soil as hitherto believed. A. B. W.

1501. *Particles of Long Range from Polonium.* **L. F. Bates** and **J. S. Rogers.** (Roy. Soc., Proc. 105. pp. 360–369, March 1, 1924.)—Polonium has been examined by the authors, using the scintillation method previously described [Abstract 1197 (1924)], for the emission of long-range particles. It has been found that for every 10^7 α-rays of range 3·93 cm. emitted, there are also present 98, 51, and 26 particles of ranges 6·1 ± 0·1, 10·0 ± 0·1, and 13·1 ± 0·2 cm. respectively, together with about 7 particles of longer range, which are probably H-particles. It is considered, from the relative brightness of the scintillations alone, that these particles are α-particles. Also, from the evidence available, it is deduced that these particles are emitted from polonium itself. The following table includes all results, dealing with long-range α-particles, up to date:

Radium C	Range cm.	3·8	7·0	9·3	11·2	13·3
	No.	300	10^6	38	12·5	6·4
Thorium C	Range cm.	4·8	8·6	11·5	15·0	18·4
	No.	$5·4\times10^5$	10^6	220	47	55
Polonium	Range cm.		3·9	6·1	10·0	13·1
	No.		10^6	9·8	5·1	2·6

A. B. W.

1502. *On the Tracks of α-Rays in Helium and Other Gases.* **W. C. McQuarrie.** (Roy. Soc. Canada, Trans. 17. Sect. 3. pp. 111–118, 1923.)—C. T. R. Wilson's cloud method was employed, with an apparatus specially designed for use with helium, modelled after that used by Bumstead for observing δ-rays in hydrogen; it was found that more rapid expansion was required for helium than for air, and a powerful spring was employed to pull down the brass piston, which moved in a brass cylinder with no packing; the fit was so exact that, with grease lubrication, helium could be left in the apparatus several days without great leakage. The range of α-particles is greater in helium than in other gases, and the ejected nucleus has a longer path and there is a better chance of detecting it; since the colliding masses are equal the α-particle may give the helium nucleus the whole of its energy; the paths may be expected to separate at right angles, if there is conservation of energy and momentum; a few stereoscopic photographs were taken which verified this. Making use of this fact and assuming that the range $R = kv^n$, where v is the velocity and k and n constants, it is possible, from observations of the angles at which the two bodies appear to leave the original α-ray track in an ordinary photograph, and the lengths of the two tracks, to determine n. In this way, from three suitable forks, the values 0·7, 0·7, and 0·9 were obtained; these are much smaller than Geiger's value $n = 3$, deduced for much faster α-particles. Blackett found $n = 1·5$ for α-particles near the end of their range in air. Some of the tracks showed a slight general curvature, and after collision sometimes much greater curvature; in some cases the track seemed to straighten out again. A collision may perhaps cause some asymmetry in the particle, which causes the curved track; Blackett has made similar observations. Quite sharp bends occur without any indication of the path of the particle to which the α-ray gave up momentum; it seems that the whole helium atom has been set in motion, and not being charged does not leave a track. Observations were made with air and hydrogen. H. N. A.

1503. *Secondary β-Rays Produced in a Gas by X-Rays.* **P. Auger.** (Comptes Rendus, 178. pp. 929–931, March 10, 1924.)—See Abstract 2449 (1923), where the author refers to the method of measurement—using a Wilson condensation chamber traversed by a beam of X-rays. The present paper deals with a detailed analysis of the observed angles of deflection of the secondary β-ray tracks. A. B. W.

1504. *The Effect of Temperature on the Luminosity of Radium Compounds.* **J. A. Rodman.** (Phys. Rev. 23. pp. 478–487, April, 1924.)—(1) In the case of pure $RaBr_2$, a tube containing 9 mg. after heating to 600° C. gave an initial luminosity of 5600 μ-candles/cm.^{2} which decreased in 1 hour to 3600 or 2800, according as the tube was cooled to 20° suddenly or gradually, and continued to decrease, according to the equation $I_t = I_\infty + I_0 e^{-At.67}$, reaching an equilibrium value of only 6μ-c./cm.^{2} after 500 hours. This equilibrium value increases somewhat with the temperature, but depends only on the temperature and not on the previous treatment. (2) In the case of mixtures with $BaBr_2$, the initial luminosity, after removing from the furnace, increases exponentially with the temperature; the rate of decay is greater the lower the temperature at which the sample is held; the equilibrium luminosity for 1 to 3 per cent. $RaBr_2$ at 20° increases markedly as the radium content decreases and for higher temperatures decreases as the temperature is increased. For 7 per cent. $RaBr_2$, however, the equilibrium luminosity at 20° is less than for either 3 or 100 per cent., and it increases with the temperature. In all cases, however, the equilibrium value depends only on the composition and on the temperature at which it is kept. These results are consistent with the suggestions by Rutherford of the formation of "active centres." AUTHOR.

1505. *Exact Measurements of Radium Emanation.* **A. Becker.** (Zeits. f. Physik, 21. 5. pp. 304–315, 1924.)—The present paper contains a brief *résumé* of the principal conditions necessary for emanation measurements free from objection, and, at greater length, a description of their practical realisation. Section 1 discusses the general principles involved in such measurements, which are either undertaken from the loss in charge of a charged system using a high-potential electrometer, or from the charging of an uncharged system evaluated by means of a low-potential instrument. Sections 2 and 3 deal with the practical details of measurements by the emanometer. Section 4 describes in full the normal radium preparations and the properties of radio-active solutions. Tables of data are included. Section 5 discusses the practice of the emanation measurement. H. H. Ho.

HEAT.

1506. *An Intercomparison of High-Temperature Scales.* **W. E. Forsythe.** (Astrophys. J. 58. pp. 294–302, Dec., 1923.)—An intercomparison has been made of the high-temperature standards now used in certain research laboratories in this country (U.S.A.) and abroad by the method of brightness temperatures as measured by the disappearing filament optical pyrometer. [See also Abstract 1889 (1923).] The "brightness temperature" of a non-black body, as determined by measuring the brightness for a given wave-length λ with the pyrometer, is defined as the temperature to which a black body must be raised to give the same brightness for the same wave-length. Thus if the brightness temperature of a body is 1500° K. for $\lambda = 0 \cdot 665\,\mu$, then for this wave-length the body has the same brightness as a black body for this same wave-length.

Several tungsten lamps which had been carefully aged in the Nela Research Laboratory, were sent to the Bureau of Standards, the National Physical Laboratory of Great Britain, the University of Wisconsin, and the Research Laboratory of the General Electric Co., requesting that the temperatures of the lamps should be measured for specified currents. In each of the laboratories the temperatures were measured with a disappearing filament optical pyrometer, using a plate of red glass as the monochromatic screen. The results give not only a comparison of the brightness temperature of tungsten but also a valid comparison of the high-temperature scale. In each laboratory the high-temperature scale is based upon: (*a*) The melting-point of gold (1336° K.) or palladium (1828° K.), (*b*) extrapolation by means of Wien's equation using for c_2 the value $14350\,\mu$ deg. Necessary reductions due to various factors such as a difference in the standard temperature, or a different value of the constant c_2 have been considered. A table is then given of the values obtained at the various laboratories, the agreement being very good. Part of the table is given below:

Lamp.	Current.	N.R.L., April, 1920.	N.P.L., April, 1922.	N.R.L., June, 1922.	Bureau, Jan., 1923.	N.R.L., Jan., 1923.
T–78–C	15·4	1825	1825	1826	1824	1828
	20·4	2262	2265	2266	2265	2269
	27·4	2746	2757	2753	2755	2755

T. B.

1507. *The Measurement of Small Sources of Heat: the Use of a Compensated Micro-Calorimeter.* **A. Tian.** (Comptes Rendus, 178. pp. 705–707, Feb. 18, 1924.)—The instrument consists of a cell placed at the centre of a constant-temperature bath and separated from it by a thermal insulator. The evolution of the heat to be measured takes place in the cell. A thermopile, joined to a galvanometer, is connected by a series of junctions with the cell and by another series with the bath, serves to measure the difference in temperature of the two media.

A second thermopile similarly placed is used to absorb, by the Peltier effect, the heat evolved. Compensation is effected by adjustment of the galvanometer deflection to zero. It is suggested that the method may be suitable for following the progress of chemical reactions where small changes in heat take place or for calorimetric observations in biology. W. C. S. P.

1508. *Physical Properties of the Paraffin Hydrocarbons.* **R. E. Wilson** and **W. H. Bahlke.** (Indust. and Eng. Chem. 16. pp. 115–122, Feb., 1924.)—Data respecting the vapour pressures, heats of vaporisation, densities, critical constants, and specific heats of the normal paraffin hydrocarbons are compiled from the literature and treated theoretically with the aid of thermodynamics, the laws of corresponding states, and similar relationships to choose between discrepant data, to fill in gaps, and to extrapolate to higher temperatures and to compounds of higher molecular weight, thus affording a fairly complete set of approximate values for the more important physical constants for all the hydrocarbons from butane to tetracosane. The practical application of the results to refinery cuts is discussed together with the necessary precautions to be observed. A. B. C. L.

1509. *The Emissive Power and Melting-Point of Tungsten.* **A. G. Worthing.** (Zeits. f. Physik, 22. 1–2. pp. 9–17, 1924.)—The paper is a description of the author's repetition of the determination of the emissive power of tungsten and a comparison with the results of other observers. A tubular tungsten wire, having small holes in the walls and electrically heated, is the source of illumination; and neglecting a small correction due to temperature difference between the inner and outer surfaces, the ratio of the brightness of the surface to that of one of the holes is the required emissive power. The comparison is made with a filament pyrometer. The spectral emission for $0 \cdot 665\ \mu$ and for $0 \cdot 467\ \mu$ at room temperature and 1330° A. was determined by the method of reflection. In this way the values obtained were:

(1) For $0 \cdot 665\ \mu$ at 300° and 1330° abs. $0 \cdot 465$ and $0 \cdot 453$.
(2) For $0 \cdot 467\ \mu$ at 300° and 1330° abs. $0 \cdot 507$ and $0 \cdot 493$.

These results seem to be in good agreement with other measurements at room temperature and very good agreement with former determinations by the author at the high temperature. The alteration in the temperature scale of W which becomes necessary is very small.

The results given by various observers for the *melting-point* of W are discussed, and assuming the melting-point of gold to be 1336° abs. and c_2 (the constant of the Wien-Planck law) $= 14{,}350\ \mu$ deg., and $0 \cdot 401$ as the spectral emissive power at the melting-point, the latter becomes 3645° abs.; or equal to 3665° abs. if $c_2 = 14{,}300\ \mu$ deg. The value is probably correct to 20° abs. W. V. M.

1510. *Freezing of Water in Capillary Systems.* **E. A. Fisher.** (J. Phys. Chem. 28. pp. 360–367, April, 1924.)—The dilatometric studies of Bouyoucos and his co-workers on soils, and of Foote and Saxton on inorganic hydrogels appear to indicate that much of the water in such systems fails to freeze even at temperatures as low as − 78° C. It was concluded, therefore, that such water cannot be present as free liquid water, but must be physically absorbed or chemically combined or in solid solution. In the present note these conclusions are criticised. It is pointed out that water present in very fine capillary tubes or pores must be under considerable tension, and hence possibly the density of such water is not necessarily the same as that of water in bulk. The conclusions of the workers cited rest on the assumption that the density of water in such capillary systems is normal. Until this point is cleared up it is difficult to accept as valid results based solely on dilatometric studies. A. A. D.

1511. *Some Experiments on the Convection of Heat in Vertical Water Columns.* **H. H. Poole.** (Roy. Dublin Soc., Proc. 17. pp. 267–273, March, 1924.)—An account is given of some experiments on the convection of heat in vertical water columns, made with a view to estimating the probable magnitude of the heat flow in stagnant water. The column of water was contained in a glass tube open at both ends and connecting an open upper vessel and a closed lower copper vessel. The lower vessel was electrically heated and the upper vessel kept cool by an immersed water worm. The whole apparatus, with exception of the upper vessel, was contained in an inverted bell jar, the intervening space being filled with granulated cork, and the jar made to float vertically in a water bath. Thermo-couples were used to measure the temperature difference between the ends of the column of water. Five sets of tests were carried out with single columns of various diameters and lengths, the former ranging from 1·07 cm. to 2·82 cm., and the latter from 10·2 cm. to 23·1 cm. Three sets of tests were carried out with double columns, consisting of two parallel glass tubes of as nearly as possible the same dimensions. The results of the tests are shown on two graphs the quantities plotted being the logarithms of temperature gradient against "convectivity." The latter is defined as the heat flow per sq. cm. of total horizontal area per sec. divided by the gradient.

The results show that the flow of heat in most cases increases much more rapidly than the temperature gradient. The smaller the column the more rapid is the rise of heat flow with rise of gradient. It is concluded that, for the small gradient existing in the earth, the effect of convection in water-logged porous rocks would be negligible. Where, however, water fissures occur, an appreciable increase in the vertical flow of heat would be expected. [See also Abstract 226 (1924).] W. C. S. P.

1512. *Free Convection of Heat in Liquids.* **R. A. Nelson.** (Phys. Rev. 23. pp. 94–103, Jan., 1924.)—*Part I. Photographic Study of Convection Streams.*—A manganin wire 0·0315 cm. diameter and 2·7 cm. long was fixed horizontally in the lower part of a rectangular glass vessel and heated electrically. The liquids surrounding the wire were water, olive oil, or glycerine. A beam of light from an arc lamp was sent through the vessel, the axis of the beam coinciding with the axis of the wire and an end-on photograph of the wire and surrounding liquid taken (magnification 3–5 diameters). For convective effects in the liquid in the immediate neighbourhood of the wire the beam through the vessel was convergent; for effects at a distance a parallel beam was used. It is seen from the photographs reproduced in the paper that there is a contraction of the convective stream a few mm. above the wire, then it becomes practically linear and finally diffuses outwards. When the wire is first heated a layer of liquid immediately round the wire becomes heated, the lower half of which first moves down, then stops and ascends joining the stream from the upper half. The stream from the upper half first ascends as a distinct semicircular pulse. The appearance of the image of the wire confirms Langmuir's suggestion of a stationary film on the surface.

Part II. Heat Losses from a Wire Surrounded by a Liquid.—The object was to investigate whether the heat loss in calories per sq. cm. (h) could be expressed in the simple form $h = b\theta^n$, where θ is the excess temperature of the wire above that of the surrounding liquid. A silver wire 0·033 cm. diam. and 16·9 cm. long was mounted as in Part I and heated electrically. After about 10 min. the steady state was reached. Its resistance was then measured and the temperature of the wire deduced. The surrounding liquid was stirred and the temperature read by a mercury thermometer. In the case of water, alcohol, CCl_4, glycerine, and castor oil, n has the values 1·15, 1·105, 1·25, 1·25, and 1·24 respectively. The measurements of A. H. Davis [Abstracts 339 and 340 (1923)] are then reduced, the losses being expressed in cals. per sq. cm. and a value of h between 1 and 1·25 is found to fit these observations. The value of b varies with the nature of the liquid and the mean temperature and probably depends on the diameter of the wire. Further experiments are necessary to elucidate this point. L. L.

1513. *Heat of Vaporisation a Function of the Temperature.* **M. M. Green.** (Am. Chem. Soc., J. 46. pp. 544–545, March, 1924.)—If the heat of vaporisation ΔH, is assumed to be a function of the temperature alone, the same function for all non-associated liquids, but differing in the constants involved, then ΔH may be put $= Tf(kT)$. That is, $\Delta H_1 = Tf(kT)$, and $\Delta H_2 = Tf(KkT)$, where k and K are constants. At the critical temperature $\Delta H_1 = T_{c1}f(kT_{c1}) = \Delta H_2 = T_{c2}f(KkT_{c2}) = 0$; $K = T_{c1}/T_{c2}$. At the boiling-points $\Delta H_1/T_{B1} = f(kT_{B1})$, and $\Delta H_2/T_{B2} = f(KkT_{B2})$. Assuming Trouton's rule, $f(kT_{B1}) = f(KkT_{B2}) = f\left(\frac{T_{c1}}{T_{c2}}kT_{B2}\right)$ from which $T_{B1}/T_{c1} = T_{B2}/T_{c2}$, or the ratio of boiling-point to critical temperature is a constant. This has been shown to be approximately true by Goldberg, the constant being about 0·66. T. B.

1514. *Joule-Thomson Effect in CO_2.* **E. S. Burnett.** (Phys. Rev, 22. pp. 590–616, Dec., 1923.)—Experimental work is described in which dry CO_2, compressed to high pressures (20 to 75 atmos.) and brought to definite temperatures (0 to 120° C.), is adiabatically expanded radially inward through the walls of a porous porcelain tubular plug, successively to several lower pressures. The observations obtained are reduced to yield isenthalpic throttling curves, the slopes of which determine $\mu = (\partial t/\partial p)_g$, the Joule-Thomson coefficient. For both liquid and vapour phases μ is found to be a linear function of the isenthalpic temperatures and an exponential function of the isenthalpic pressures of such curves. In the liquid region μ becomes zero at $-24°$ C. for all pressures involved and is negative at lower temperatures. An empirical relationship is formulated to represent the entire experimental field for both phases, including the transition region in the vicinity of the critical point and along the saturation curve. Isenthalps, isotherms, and isobars thus computed for the range 0–100 atmos. from the solid-liquid phase-boundary at about $-55°$ C. through the liquid field into the superheated vapour field as far as $+150°$ C. are presented in tabular and graphical form. The results obtained from the experimental isenthalpic curves are compared with those obtained from other sources, and all show good agreement with Keyes' equation. A. B. C. L.

1515. *The Critical Constants of Various Gases.* **F. S. Pickering.** (J. Phys. Chem. 28. pp. 97–124, Feb., 1924.)—The literature referring to the critical constants of the more common gas is critically reviewed, and the following values of the respective constants chosen as probably the best values, reasons for the choice being given in each case.

Gas.	Critical Temperature.	Critical Pressure.	Critical Density.
	°C. Abs.	Atm.	g. per c.c.
Acetylene	309 ?	61·6	0·231
Air	132·4	37·2	0·35*b* 0·31*c*
Allylene	401	—	—
Ammonia	405·5	112	0·236
Argon	150·7	48·0	0·52
Butane(iso)	406·8 ?	36·5 ?	—
Butane(n)	426·3 ?	35·7 ?	—
Carbon dioxide	304·1	72·9	0·460
Carbon monoxide	134·4	34·6	0·311
Chlorine	417	76	0·573
Cyanogen	401·4	59·7	—
Ethane	305·2	48·8	0·21
Ethyl chloride	456 ?	54 ?	—
Ethylene	282·6	50·7	—
Helium	5·20	2·26	0·066
Hydrogen	33·18	12·8	0·0310
Hydrogen bromide	363·5 ?	—	—
Hydrogen chloride	324·5	83 ?	—
Hydrogen iodide	423·9 ?	—	—
Hydrogen sulphide	373·5	89	—
Krypton	210·6 ?	54·3 ?	—
Methane	190·6	45·7	0·162
Methyl chloride	416·2	65·9	0·37 ?
Neon	44·7	26·9	—
Nitric oxide	180 ?	71 ?	—
Nitrogen	126·0	33·5	0·3110
Nitrous oxide.........	309·6	71·7	0·45 ?
Oxygen	154·3	49·7	0·430
Ozone	268 ?	92·3 ?	—
Phosgene	456 ± 0·5 ?	—	—
Propane	368·7	45	—
Propylene	364·5 ?	45·3 ?	—
Sulphur dioxide........	430·3	77·7	0·52 ?
Xenon	289·7	58·2	1·155

J. S. G. T.

1516. *The Influence of the Neighbourhood of the Critical State of Miscibility on Volumes.* **N. Perrakis.** (Comptes Rendus, 178. pp. 703–705, Feb. 18, 1924.)—The author has carried out experiments on the variation in volume with molecular concentration of the systems (I) *o*-Cresol-ethyl alcohol, and (II) Di-phenyl oxide-ethyl alcohol. The observations were made at a temperature of 30° C. and the results shown in the form of curves of the variation in volume for 1 mol.-gramme of the mixture against the molecular concentration. System I gave a curve parabolic in nature, but System II gave a curve which had a portion clearly rectilinear. The author suggests that this deformation of the curve is due to the neighbourhood of the critical state, and not due to the existence of chemical combination, as is stated by some authors. W. C. S. P.

1517. *Entropy in a Monatomic Perfect Gas.* **E. Fermi.** (Accad. Lincei, Atti, 32. ii. pp. 395-398, Dec. 2, 1923.)—Revision of the work of Sackur [Abstract 463 (1913)], Tetrode [Abstract 1389 (1912)], and Stern [Abstracts 1977 (1913) and 1446 (1920)], eliminating certain assumptions but confirming the result, *viz.* that

$$\text{Entropy} = \mathrm{N}k\left\{\frac{5}{2}\log_e \mathrm{T} - \log_e p + \log_e \frac{(2\pi m)^{3/2}k^{5/2}e^{5/2}}{h^3}\right\}$$

where N is the number of atoms, k is Boltzmann's absolute constant, T is the absolute temperature, p is the pressure, m is the mass of the atoms, and h is Planck's constant. A. D.

1518. *Comment on the Remarks of Berthelot Relative to the Paper by Bochet on the van der Waals Law of Corresponding States.* **Bochet.** (Comptes Rendus, 178. pp. 992-993, March 17, 1924.)—Berthelot considered [Abstract 1232 (1924)] that the author had incorrectly stated van der Waals' definition of the critical point as the point at which the corresponding isothermal has a point of inflection with a horizontal tangent. It is maintained that this is merely the geometric statement of the algebraic requirement that three roots of the equation should be equal. T. B.

1519. *The Present Status of the Constants and Verification of the Laws of Thermal Radiation of a Uniformly Heated Enclosure.* **W. W. Coblentz.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 11-15, Jan., 1924.) —In a previous report [Abstract 279 (1921)] the experimental work on the determination of the radiation constants up to the year 1920 was reviewed and criticised. In the present report later determinations are considered. As regards the *total radiation constant,* after reviewing the work of Wachsmuth and Vierheller, and Hoffmann [Abstract 1866 (1923)] the author concludes that the new data substantiate the previous value for σ, *viz.* $5{\cdot}73 \times 10^{-12}$ erg. cm.$^{-2}$ deg^{-4}.

The *constant of spectral radiation* is then considered. Recent work of Rubens and Michel [Abstracts 157 and 2307 (1922)] confirms the previous conclusion that Planck's equation represents the energy distribution of a black body in the spectrum extending from $0{\cdot}5\,\mu$ to $50\,\mu$. No high accuracy is claimed by Michel for his value of C, *viz.* $14{,}270 \pm 0{\cdot}18\,\%$, his object being to prove Planck's formula for a determined magnitude of λT. The average of the data summarised in the previous report gave a value for C of 14,320 micron degrees, which is practically the theoretical value and which the author considers should be retained. L. L.

SOUND.

1520. *Acoustic Problems of the Gramophone.* **H. L. Porter.** (Phys. Soc., Proc. 36. pp. 129–131, Feb., 1924. Inst. El. Eng., J. 62. pp. 273–274, March, 1924.)—The author (with P. Rothwell) has worked for some time on gramophone reproduction, and the investigators have decided that the gramophone is not, as it had been in the past, a question of improving the "soundbox" (as the diaphragm and its housing is termed) independently of the recording horns, or of improving the recording horns independently of the soundbox, or of both independently of the room conditions. The combination, including the *room,* have to be considered as one acoustic system and treated as such. E. H. B.

1521. *Auditorium Acoustics and the Loud-Speaker.* **G. A. Sutherland.** (Phys. Soc., Proc. 36. pp. 142–148, Feb., 1924. Inst. El. Eng., J. 62. pp. 280–283, March, 1924.)—Describes the theories of auditorium acoustics as developed by W. C. Sabine, Jäger, and others, and illustrates the state of things in different auditoria and their bearing upon the problems of loud-speakers. A number of valuable graphs illustrate this lucid paper. E. H. B.

1522. *Relative Importance of Each Frequency Region in the Audible Spectrum-Measurements on Loud-Speakers.* **E. K. Sandeman.** (Phys. Soc., Proc. 36. pp. 132–138, Feb., 1924. Inst. El. Eng., J. 62. pp. 275–278, March, 1924.)—The relative importance of each frequency in the audible spectrum depends on what function of hearing is to be served. Three essential characteristics of reproduction are important: (1) Intelligibility of speech, (2) naturalness of reproduction of music and speech, (3) reproduction of speech at correct volume. By the use of the Campbell electrical wave filters, the high frequencies or the low frequencies may be allowed to pass and the intelligibility and other functions of hearing tested. The results are shown by graphs, the apparatus being illustrated by a diagram. E. H. B.

1523. *Tests of Auditory Acuity.* **C. C. Bunch.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1161–1166, Dec., 1923.)—Various types of electrical apparatus are rapidly replacing the tuning-forks as sources of sound for tests of auditory acuity because of the ease, accuracy, and constancy with which the results may be secured. The recent development and practical application of the vacuum tube has added impetus to work in this field. F. W. Kranz (Phys. Rev. p. 384, 1921), R. L. Wegel [Abstract 2118 (1922)], J. P. Minton [Abstract 1348 (1922)], C. E. Lane [Abstract 1889 (1922)] and others in the field of physics have made accurate determinations of the energy required for producing the minimum audible sound. J. Guttman (Laryngoscope, p. 829, 1922), also Hastings and Tucker (Proc. Roy. Soc. of Medicine, 1923) have attempted the adaptation of such results to diagnosis in clinical cases. In describing their results these writers assert correctly that by the adjustment of capacity and inductance in the electric circuit the complete range of audible tones may be produced. Inspection of the results shows, however, that the measurements are usually confined to a few tones scattered over a considerable range. The tone " gaps " and " islands " demonstrated by Bezold are variable in both location and extent and are of considerable clinical significance.

The determination of the acuity of hearing for all tones through a wide range of frequencies is made possible by means of a recently developed instrument known as the *pitch range audiometer*. The essential features of this audiometer are a variable frequency alternating-current generator connected through a series of resistances to a telephone receiver. Accessory parts are a variable-speed driving motor with its controlling rheostat, and an electric tachometer which indicates the generator speed in vibrations per seconds. The author believes that tone quality is pure enough for the functional tests of hearing. Graphs are given of the fields of hearing as found by this audiometer for two cases, one with normal hearing and one with injured ears and suppuration. The paper closes with a valuable list of articles on this subject. E. H. B.

1524. *Low-Hilger Audiometer.* (Engineering, 117, pp. 108–109, Jan. 25, 1924.)—In the investigation of many acoustical problems useful information may be obtained by analyses of the form and amplitude of the sound waves in air. For this purpose the audiometer here described is now available. It not only permits the form of sound waves to be examined visually, but also gives a permanent photographic record if desired. The instrument, which was formerly known as the Hilger optical sonometer, is made by the Hilger firm for the Low Engineering Co., who have made considerable use of it in testing the noises arising from machinery, with a view to their reduction. The form of construction is shown by a photographic view and a section. A 30-candle-power pointolite lamp is used and the wave pattern obtained may be seen on a screen or received and photographed on a film carried on a drum actuated by a gramophone motor. The sound is concentrated by a horn upon a diaphragm, which may be made of rubber or other materials, but is usually an extremely thin film of celluloid, mounted on a stout metal ring. Those for speech sounds have a thickness of about 2 $\mu\mu$. A small portion of the surface of the diaphragm, on one side of the centre, is rendered reflecting by a kathodic deposit of platinum. This forms the mirror to reflect the light from the lamp to the screen or film. To avoid the detrimental effects of resonance, diaphragms are supplied of frequencies ranging from 80 to 3000 per second. The article contains a number of vibrational records. E. H. B.

1525. *Acoustic Wave Filters: Attenuation and Phase Factors.* **G. W. Stewart.** (Phys. Rev. 23. pp. 520–524, April, 1924.)—*Theoretical Discussion.*—The ratio of the rate of volume displacements in successive sections e^{Y} is equal to $e^{-\alpha} e^{-i\phi}$ where α is the attenuation constant and ϕ the decrease in phase from section to section. If Z_1 and Z_2 are the impedances in the conduit and branch respectively, it is shown that in the region of no attenuation, $\cos\phi = 1 + \frac{1}{2}Z_1/Z_2$ and ϕ changes from 0 to π, while in the attenuated region ϕ is either 0 or π and $\cosh\alpha = |(1 + \frac{1}{2}Z_1/Z_2)|$, becoming infinite for the natural frequency of the side branch, while ϕ passes discontinuously from 0 to π or π to 0. *Experimental Values of Phase Change ϕ.*—Sound from various points along the filter was transmitted to one ear and the relative phase was determined from the apparent direction of the phantom source. For a low-pass filter the values of the total change per section agree well with the theory, except that the change occurs gradually instead of suddenly, but agreement was not found in the cases of the other two types. **Author.**

1526. *Predicted Transmission Curves of Acoustic Wave Filters.* **H. B. Peacock.** (Phys. Rev. 23. pp. 525–527, April, 1924.)—Using the experimental procedure of G. W. Stewart [see preceding abstract], the energy transmitted as a function of the frequency was determined for a low-frequency-pass, a high-frequency-pass, and a single-band-pass filter. Corrected for dissipation, the results agree well with the theoretical curves computed from Stewart's equation for a filter of n sections $I_n/I_0 = e^{-n\alpha}$, where α, the attenuation factor, is computed from the impedances.

Author.

1527. *Helmholtz Theories of Struck String. Part I. Theoretical.* **W. H. George.** (Phil. Mag. 47. pp. 591–602, March, 1924.)—The problem of the struck string has been theoretically treated by two methods. *First*: Helmholtz, Delemer, and Lamb have each assumed some special form for the function expressing the pressure between the hammer and the string during the time of contact. Proceeding from these pressure-time laws and using some additional assumptions, each of these writers obtains finally an expression giving the intensities of the partials of the vibrating string. None of these treatments by this first method appears to have been subjected to quantitative experimental tests. The *second* method of treatment is that due to Kaufmann [Wied. Ann. liv. pp. 675–712 (1895)], who considered the problem of the impact of a massive unyielding particle on the string. He gave a rigorous treatment for a string of infinite length and also for a finite string struck at the middle (with the limitation, in this second case, that the time of contact of hammer and string is not greater than the fundamental free period of the string). Kaufmann also treated the case of a string struck near one end by neglecting the vibrations of the shorter piece of string during the impact, and obtained an approximate solution for the case in which the ratio of time of contact to free period is not greater than that of distance of struck point from further bridge to length of string. P. Das (1921) has repeated this work, taking into account the vibrations of the shorter piece of string, but retaining the limitation as to time of contact. Kaufmann gave no treatment for a string struck at one-third its length from an end. Raman and B. Banerji (1920) have extended Kaufmann's work by regarding the motion during impact as that of a loaded string to which Rayleigh's well-known treatment might be applied.

In this first part by the present author the Helmholtz theory for the hard hammer is considered in detail, and is shown to be in conflict with experimental evidence so far available. The Helmholtz theory for the elastic hammer is next considered, but with the omission of two assumptions which caused Kaufmann to reject the theory. Expressions are found for quantities whose magnitude can be determined from photographically obtained displacement-time curves of the struck point. Expressions for the same quantities are derived from Kaufmann's theory of the string struck at the middle or near one end. Thus the way is paved for the comparison of these theories with experiment, this being reserved for the second part of the work to be published shortly. The paper is illustrated by graphs and photographic reproductions [see Abstract 737 (1920) and 1674 (1922)]. E. H. B.

1528. *Nature of Language: Physics of Speech and Hearing.* **R. L. Jones.** (Am. I.E.E., J. 43. pp. 321–328, April, 1924.)—Human speech employs frequencies from 60 to above 6000 per second, a range of about six octaves. The ear can perceive sound waves ranging in pressure amplitude from less than one-thousandth of a dyne (per sq. cm.) to over one thousand dynes and in frequency of vibration from about twenty to about twenty thousand per second, a range of about ten octaves. The intensities and frequencies used most in conversation are those situated in the central part of the area of audition. The energy of speech is carried largely by frequencies below a thousand per second, but the characteristics which make it intelligible, largely by frequencies above a thousand. Under quiet conditions good understanding is possible with undistorted speech having an intensity anywhere from one hundred times greater, to a million times less than that at exit from the mouth. On the whole, the sounds, *th*, *f*, *s*, and *v* are hardest to hear correctly; and they account for over half the mistakes made in interpretation. Failure to perceive them correctly is principally due to their very weak energy, but it is also to be noted that they have important components of very high frequency. A number of important graphs are included in the paper. E. H. B.

1529. *Speeds of Sound in Gases and Vapours and Ratios of Specific Heats.* **H. B. Dixon** and **G. Greenwood.** (Roy. Soc., Proc. 105. pp. 199–220, Feb. 1, 1924.)—The experiments here described were made in continuation of those carried out by Dixon, Campbell, and Parker [Abstract 605 (1922)]. The object was to determine the speeds of sound in the vapours of the low-boiling inflammable liquids ether, methyl and ethyl alcohols, pentane, hexane, and benzene, and incondensable gases such as ethylene and ammonia.

The speeds of sound were measured directly by timing the passage of a sound wave between the two ends of a coiled lead pipe 25 mm. internal diameter containing the vapour or gas under test and brought to the temperature desired by means of an adjusted water bath. The chief results are as follows:

Substance.	Temperature.	Speed of Sound.	Ratio of Specific Heats.
	°C.	m./sec.	
Dry air	20	339·5	—
Ether	80	201·8	1·086
Pentane	86	206·1	1·086
Hexane	80	184·2	1·080
Ethyl alcohol	90	266·0	1·129
Methyl alcohol..........	77	322·8	1·203
Benzene	90	199·25	1·097

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1530. *Electric Field of the Electrolytic Cell.* **A. A. Ahmed.** (Inst. El. Eng., J. 62. pp. 301–317, April, 1924.)—The type of cell studied is one having plane parallel electrodes. Considering the case of two-dimensional flow, and using the method of conformal representation, the author applies Christoffel and Schwarz's transformation to determine the distribution of electric intensity over the surface of either plane electrode. The results obtained are verified experimentally by the use of two exploring wire electrodes (spaced 1 cm. apart) connected to an electrometer, the electrolyte being copper sulphate. The following method of determining the current-density at any point of an electrolyte is described: the exploring electrodes having been so placed that the line joining them is coincident with a stream-line (corresponding to maximum reading of electrometer), a current from an auxiliary source is passed between the electrodes so as to oppose the current flowing in the electrolyte, the auxiliary current being adjusted until the p.d. between the exploring electrodes is reduced to zero; the auxiliary current is then proportional to the current-density. The experimental results show that stream-lines of current flow are coincident with lines of electric intensity—so that problems in electrostatics are capable of being replaced by equivalent problems in electrolytic conduction. The paper concludes with a calculation of the conductance of a cell with plane parallel electrodes. A. H.

1531. *Atmospheric Pollution and Potential Gradient, Kew.* **C. Chree** and **R. E. Watson.** (Roy. Soc., Proc. 105. pp. 311–333, March 1, 1924.)—The observations suggest that atmospheric pollution exerts a considerable influence on the phenomena of atmospheric electricity. The results obtained are tabulated and discussed in detail, together with the meaning of the pollution tests, and the influences exerted by the position of the Owen's apparatus, and of meteorological conditions at the time of observation. The question of the utility of Kew observations on atmospheric electricity is also discussed, and the conclusion is reached that it would be a mistake to discontinue the Kew observations; but the suggestion is made that it would be advantageous to compare Kew and Greenwich, on opposite sides of London, and to have a station in some part of South England, where the air is as pure as possible. W. A. R.

1532. *Observations of Earth Potential Gradients at Ebro.* **S. Chapman** and **T. T. Whitehead.** (Terrest. Magn. 28. pp. 125–128, Dec., 1923.)—In an earlier paper [see Abstract 2329 (1922)] the diurnal variation of the electric potential gradient within the earth, to be expected from the magnetic variations, was worked out and compared with actual observations made by Weinstein at Berlin. Fair agreement of type of variation was obtained, but amplitudes could not be compared, Weinstein's unit being unknown. L. A. Bauer's discussion of recent earth-current observations at Ebro [Abstract 121 (1923)] has provided opportunity for further work in this direction. The type of variation is again in approximate agreement, but the amplitude of the observed variation of earth potential gradients at Ebro is five or six times that expected from the magnetic variations. The discrepancy is, as yet, unexplained, but note is made of certain other peculiarities of the Ebro results, which are difficult to account for, in particular the surprisingly high values of the average earth potential gradients and their surprising variability from month to month. M. A. G.

1533. *Atmospheric-Electric Observations during the Total Solar Eclipse of September 10, 1923.* **H. F. Johnston.** (Terrest. Magn. 29. pp. 13–22, March, 1924. Paper read before the Phil. Soc. Washington, March, 1924.)—The Department of Terrestrial Magnetism made observations of potential gradient, positive conductivity, and negative conductivity at Point Loma near San Diego, California, on September 10, 1923, as well as control observations on the four preceding and following days. Improved bifilar electrometers, which gave dependable determinations of potential, were used. Potential gradient was observed both by eye-readings and by continuous photographic registration. Conductivity was observed simultaneously with two Gerdien conductivity apparatuses. Meteorological conditions were very steady for the day of the eclipse; there was a total range of 2°·5 centigrade in temperature, 9 per cent. in relative humidity, and 0·02 inches in barometric pressure. During the 20 minutes following totality, the temperature decreased 0°·8 centigrade, and the relative humidity increased 3 per cent. The sky was completely overcast with fog which extended above 17,000 feet. It was found that the potential gradient for about half an hour immediately following totality was about 15 per cent. subnormal. The electrical conductivity of the air and the air-earth current-density increased about 10 per cent. above normal during the 10-minute period following totality. There was a greater increase in the negative conductivity than in the positive conductivity of the order of 15 per cent. AUTHOR.

1534. *Correlations between Solar Activity and Atmospheric Electricity.* **L. A. Bauer.** (Terrest. Magn. 29. pp. 23–32, March, 1924).—The question is revived whether atmospheric electricity is in any way dependent upon solar activity. The present investigation is based chiefly upon the accumulated data for electrically quiet days pertaining to the atmospheric potential-gradient and its diurnal and annual variations. It is found that during the past two sun-spot cycles (1901–1923), the atmospheric potential-gradient and the amplitudes of the diurnal variation and of the annual variation generally increased with increased sun-spot frequency; the increase in the particular electric element considered is about 20 to 35 per cent., on the average, for a change of 100 in the sun-spot number. The correlation coefficient, on the average, is about 0·75. If reliance can be placed on older series of atmospheric-electric observations, made prior to 1901, then there are indications that during two periods, centring about 1855 and 1889, the reversed relationship applied, namely, that increased atmospheric potential-gradient and increased amplitudes of diurnal and annual variation were associated with decreased sun-spot frequency.

An interesting correlation is exhibited by the atmospheric-electric and magnetic data for 1893, which unite in showing a decrease in the electric and in the magnetic activity at the time of maximum sun-spot frequency. There is thus an indication that the usual measures of solar activity are not always an adequate measure of such solar radiations and emanations as may affect the electricity of the atmosphere and the magnetic field of the earth. [See also Abstract 2117 (1923).] AUTHOR.

DISCHARGE AND OSCILLATIONS.

1535. *Ions from Hot Salts.* **O. Gossmann.** (Zeits. f. Physik, 22. 4. pp. 273–274, 1924.)—Observations on a large number of salts extending those of Schmidt and Walter [Abstract 627 (1924)]. Positive ions begin to be given off at some 30° lower on nickel than on platinum. A. D.

1536. *Measurement of Ionisation Currents.* **R. Kegerreis.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1245–1251, Dec., 1923.)—Formulates a method for eliminating leakage, inductive interference, and currents due to infiltration. The apparatus is sheltered by a conducting sheath, and insulations and cross-conductors are introduced. A. D.

1537. *Life of Metastable Helium.* **F. M. Kannenstine.** (Astrophys. J. 59. pp. 133–141, April, 1924.)—*Dependence of Critical 4·8-Volt Striking Frequency on Pressure.*—The critical 4·8-volt striking frequency for alternating helium arcs was obtained under improved experimental conditions for pressures from 0·15 mm. to 10 mm. The critical frequency decreased rapidly from 260 cycles per second at 0·15 mm. pressure to 120 cycles at 0·75 mm., more slowly to 70 cycles at 2 mm., and remained practically constant at 70 cycles to 10 mm. The critical frequency increased very slightly as the arc-length decreased from 30 mm. to 10 mm. for pressures below 3·5 mm., but was practically independent of the arc-length used for pressures above 3·5 mm. and up to 10 mm.

Interpretation of Results on the Concept of a Long-Lived Abnormal Helium Atom.—The constancy of the critical frequency over a large range of pressures and arc-lengths is more naturally interpreted on the concept of a long-lived, abnormal atom than on ideas which suggest a strong dependence on pressure such as the handing on of radiation or the imprisonment of radiation as suggested by F. Horton and Ann C. Davies, and by K. T. Compton. The departure from constancy at low pressures may be interpreted as due to such rapid diffusion of abnormal atoms from the arc space that higher frequencies are necessary to obtain an indication of striking. AUTHOR.

1538. *Determining Factors in the Life of Metastable Helium.* **A. J. Dempster.** (Astrophys. J. 59. pp. 142–147, April, 1924.)—The experiments of Kannenstine on the life of metastable helium are compared with a theory in which the effects of impurities and diffusion are treated mathematically. If the impurity has a constant partial pressure of $1 \cdot 8 \times 10^{-5}$ millimetres of mercury and the diffusion coefficient for the metastable atoms is one-third of that given by the kinetic theory of gases for normal helium, agreement is found on the idea that collisions with the wall cause the metastable state to revert to the normal at once. The dependence of frequency on pressure deduced from a theory of radiation diffusion is found not to agree as well as that based on the idea of a metastable state of the atom which persists until destroyed by a collision with an impurity or with the walls. AUTHOR.

1539. *Ionisation by Collision in Helium.* **J. S. Townsend** and **T. L. R. Ayres.** (Phil. Mag. 47. pp. 401–415, Feb., 1924.)—The helium is in a vessel between two silver plates, between which a difference of potential is maintained. Ultra-violet light falls on the negative plate and the current between the two plates is measured for various values of potential difference, gas pressure, etc. The results suggest that some of the recent views of ionisation are erroneous. Everything points to the fact that the ionisation is merely due to collisions between the electrons liberated by the light and molecules. There is nothing to suggest ionisation by collision with positive ions, or to electrons set free from the negative plate, either by impacts of positive ions or by radiation from molecules of the gas. The results also differ from those to be anticipated on the basis of the quantum theory applied to this case. The statements frequently made as to the loss of energy of electrons in amounts corresponding to resonance potentials are inconsistent with these experiments and similar experiments made with other gases. A. A. D.

1540. *Impact Effects in Nitrogen and Nitric Oxide.* **C. B. Bazzoni** and **A. T. Waldie.** (Frank. Inst., J. 197. pp. 57–72, Jan., 1924.)—A brief survey is given of the difficulties associated with the study of complex or chemically active gases by impact methods and details of experiments are described from which it is concluded that NO at low pressures is not broken down by ultra-violet light or by heat radiation, but that hot metals produce a dissociation and subsequent elimination of the O, leaving, essentially, N. It is demonstrated that the virtual free path of electrons in N must be several times that predicted by the kinetic theory. It arises, incidentally, that the dimensions of the apparatus (grid distance) determine the appearance of the higher critical points of N. Evidence is presented for the suggestion that the 8-volt resonance point and the 17-volt ionisation point are characteristic of the atom, while the higher points, specifically the 24-volt point, are connected with the ionisation of the molecule. Attention is drawn to the important part played by the electrodes and gas and metal films in catalysing dissociations and other reactions in experimental devices of the type employed. A. B. C. L.

1541. *Ionisation of Salt Vapours.* **V. Kondratjeff** and **N. Semenoff.** (Zeits. f. Physik, 22. 1–2. pp. 1–8, 1924.)—The method developed by Smyth [see Abstract No. 2241 (1923)] for measuring the ionisation potential and mass of the ions in vapours of salts is employed for the investigation of $HgCl_2$ and HgI_2 vapours. It is found that univalent halogen ions are produced above a critical potential of about 11 volts, which indicates a process similar to electrolytic dissociation. The analysis of the positive ions produced shows the existence of ions such as HgI_2^+, HgI^+, I^+, Hg^+, Hg^{++}. It follows, therefore, that other types of dissociation must be taking place in addition to the simple case quoted above. B. W. C.

1542. *Effect of Heat Treatment on the Photoelectric Emission from Platinum.* **F. G. Tucker.** (Phys. Rev. 22. pp. 574–581, Dec., 1923.)—The investigation is undertaken with a view to obtaining additional evidence of the nature of photo-electrons, by means of the study of the temperature variation of the photoelectric *threshold* or long wave-length limit (λ_0) of platinum denuded of gases by glowing at high temperatures. A thin Pt foil is mounted between heavy leads inside a Faraday cylinder in a Pyrex tube with a quartz window. λ_0 is determined by plotting current per unit light intensity against wave-length of the Hg-arc line used, and is found to vary with previous heat treatment. After 8 hours at 900° C. the foil gives a value about 2700 Å., and after 4 to 5 hours at bright yellow heat λ_0 drops to 2475 Å. Immediately after 2 hours' heating to over 1400° C, the emission from the suddenly cooled foil is found to be zero, even under the influence of the full radiation of the Hg arc, but after 5 minutes photo-emission begins, increasing rapidly at first and then more slowly. It is deduced that λ_0 for pure gas-free Pt must be below 1849 Å. and that the effects ordinarily observed must be due to a gas film or some other surface film. After moderate heat treatment of the foil λ_0 is the same at 600° as at 20°, indicating that the film responsible for the emission is unchanged and that the threshold under these conditions does not depend on the kinetic energy of the free electrons in the foil. A. B. C. L.

1543. *Radiation from Oxides Emitting Kathode Rays.* **K. Teucke.** (Phys. Zeits. 25. pp. 115–119, March 1, 1924.)—The luminous (ultra-violet, to infra-red) radiation emitted from an incandescent oxide-coated metallic filament when emitting an intense stream of kathode rays is proved by several methods to be entirely a temperature effect. A. B. W.

1544. *Thermodynamics of Electron Emission.* **O. W. Richardson.** (Roy. Soc., Proc. 105. pp. 387–405, April 1, 1924.)—This paper deals with some applications of thermodynamics to the electron atmospheres in equilibrium with matter. The treatment is a development of earlier papers [see Abstract 925 (1912)] and the former ground is traversed again to a certain extent. This has become especially desirable because recent improvements in technique are enabling some of the finer points of the theory to be tested by experiment. In the discussion the author keeps throughout to electron atmospheres which are so attenuated that the forces exerted by the electrons on each other are quite negligible. For the theory of the complications which arise when this condition is not satisfied, v. Laue's work should be consulted. The first topic considered is that of thermionic emission at melting and transition points, and a number of relations are found between the quantities which fundamentally underlie thermic phenomena. These relations do not prescribe any very severe restrictions as to the kind of occurrences which may take place, for example, at transition points. If there is no change in the saturation current at a transition point, there will be zero contact potential difference between the two phases. The current may be either continuous or discontinuous at a transition point and the constants A and b in the equation $i = AT^2\epsilon^{-b/T}$ change in various ways. The next topic is the universal constant C [Abstract 1451 (1915)], which is now restricted to metallic substances that conduct electricity at T = 0. In the section on metallic conductors it is concluded definitely in favour of the type of theory which makes the kinetic energy of the conducting electrons in metals independent of temperature as opposed to the requirements of the classical theory. Finally the temperature variation of the latent heat of evaporation (per electron) and associated questions are discussed. H. H. Ho.

1545. *The Modification of the Thermionic Current in Vacuum Tubes when Potassium Deposited on the Inside Walls or Grid of the Tube is Illuminated.* **J. M. Hyatt.** (Phys. Rev. 23. pp. 501–506, April, 1924.)—When a floating grid mounted between a plate and filament in a spherical tube is coated with potassium and illuminated, it loses a negative charge and produces a considerable increase in the plate current, equivalent to that due to maintaining the unilluminated grid at a positive potential of a few volts relative to the filament. In the case of a long tube with a constricted cylindrical portion between the plate and filament ends, an illuminated coating of potassium on the walls reduces the tendency of the walls to charge negatively and hence facilitates the passage of the current through the tube. As the filament current is increased for a given plate voltage the current reaches a maximum, then suddenly drops to a minimum, due to the combined action of space charge and photoelectric emission. AUTHOR.

1546. *The Physical Process in a Mercury-Vapour Rectifier.* **A. Günther-Schulze.** (Zeits. techn. Physik, 5. 2. pp. 33–39, 1924. From the Reichsanstalt.)—Electric valves for rectifying alternating current are briefly discussed and then the matter is dealt with under the following heads: (*a*) In the direction of transmission, (*b*) not in the direction of transmission. In section (*a*) the following points are considered in detail: (1) The process at the kathode, (2) the process in the gas tract, (3) the process at the anode. The effects on the loss of tension produced by the introduction of foreign gases, such as SO_2, O_2, H_2, N_2, CO_2, Ar, are shown graphically, and photographs of the appearance of the light arc under different conditions are also given. A. E. G.

1547. *Normal Gradient in Gases.* **A. Günther-Schulze.** (Zeits. f. Physik, 22. 1–2. pp. 70–97, 1924. From the Reichsanstalt.)—In Geissler, or arc discharges, a certain potential-slope or normal gradient is requisite in order to enable the electrons and kations to travel. When the walls are so distant as to be without influence, this normal gradient is a constant, characteristic of the particular gas. A. D.

1548. *On the Kathado Luminescence of Solid Solutions of Forty-Two Metals.* **T. Tanaka.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 287–318, Feb., 1924.)—The number of solids whose luminescence can be explained by assuming an activating metal in solid solution has been so widely extended that there remain, at least for inorganic substances, only a few exceptions, such as the uranyl salts, platino-cyanides, etc. Prior to the investigations of Nichols, the work had been mainly qualitative, but the above-named showed by means of a spectro-photometer that each broad luminescence band could be resolved into several series of component bands with systematic inter-relations. The same method is now applied to the study of solid solutions of a large number of metals. The method of excitation adopted was by kathode rays obtained in a vacuum tube carrying currents of about 9·4 milliampere. The discharge potential, measured with a spark-gap voltmeter, was about 4000 volts. Full experimental details are included in Section I of the paper. In Section II solid solutions with manganese and with copper as their active substances are investigated, these being the sulphate, carbonate, and phosphate of calcium, the sulphates of zinc and magnesium, and ammonium alum. All the solid solutions with manganese or copper as their active metals show luminescence spectra which can be resolved into series of component bands characteristic of manganese or copper generally. The solvents determine the position of maximum brightness, and, in a few cases produce a slight modification in the positions of the bands. Section III deals with the sulphides of Lenard and Klatt, the kathodo-luminescence spectra of 27 samples having been studied. Just as in electrolytes, whatever bases may be used, dissolved active metals show their characteristics. For each active metal there are characteristic series of constant frequency interval. Series of this kind were determined for copper and manganese and are the same as those found for these metals in Section II. Series were likewise established for lead, bismuth, silver, and antimony which had not been previously investigated. In a few cases anomalous series were found which can be obtained from the normal series for the metal in question, by the addition of a small constant amount to each member. The base seems to determine the colour of the luminescence, but the flux has no important effect. Except in the case of zinc, no indication of impurities could be found. Section IV deals with the solid solutions of 36 other metals. Section V considers relations to the atomic weight. When about ten active substances had been studied, it was unexpectedly found that a smooth curve could be drawn by plotting the mean value of the characteristic intervals of each active metal as the ordinate against the atomic weight of the metal as abscissa.

In all 129 solid solutions with 42 metals as active agents have been examined. Whatever bases are used, each dissolved metal shows its characteristic luminescence even if faintly. Each luminescence spectrum is composed of several series of overlapping bands, each series spaced equally in frequency units. Each metal has in most cases two, but sometimes four, rarely one or three, series characteristic of it, and there exist two characteristic frequency intervals different or coincident which are totally independent of the properties of solvents. The average of these two intervals decreases quite regularly with the increase of the atomic weight. High luminescent powers are exhibited by the active metals of Lenard and Klatt's sulphides and by gallium, praseodymium, samarium, dysprosium, erbium. The paper includes 42 tables of data. H. H. Ho.

1549. *Potential Distribution between Parallel Plane Electrodes.* **T. C. Fry.** (Phys. Rev. 22. pp. 445–446, Nov., 1923.)—The objections raised by Langmuir [see Abstract 1650 (1923)] to the results previously given by the author [see Abstract 1145 (1921)] were due to a misunderstanding of the meaning of the symbol V_0, which is here explained in greater detail. Some typographical errors are also pointed out. AUTHOR.

1550. *Electrical Strength of the Air between Plate Electrodes.* **H. Zipp.** (Archiv f. Elektrot. 12. pp. 608–609, Feb. 29, 1924.)—Referring to the remarks of W. O. Schumann on the author's paper on this subject [Abstract 951 (1924)], the latter explains that the field divergences appearing even in the middle of condenser plates of limited dimensions, which he commented upon, were not founded so much on the effect of the edges of the field as Schumann assumes but much more on the fact that the lines of force produced in a given condenser arrangement must so arrange themselves that the dielectric resistance possesses the smallest possible value. The consideration of the divergences in the case of the small circular plates in the arrangement used by Schumann call for correction factors which lie between 1·0265 and 1·117. The mean value $E_{max.} = 30{,}200$V/cm. calculated by the author on the basis of theoretically determined correction factors agrees so strikingly with the mean value $E_{max.} = 30{,}580$ V/cm. found by Schumann from the results of measurement that he cannot believe it to be a coincidence. J. J. S.

1551. *Electric Strength of the Air between Plate Electrodes.* **W. O. Schumann.** (Archiv f. Elektrot. 12. p. 610, Feb. 29, 1924.)—Commenting on the criticism by H. Zipp of his former paper [see preceding abstract], the author says that when he mentioned the effect of the edges which could influence the field in the middle of the plane condenser he meant to include therewith all influences which were produced by the circumscribed condition of the electrodes. The correction factor of 1·02 given by the author may be considered as the upper limit of a possible error. J. J. S.

1552. *Initial Discharge Voltage and Breakdown Field Intensity of Spherical Electrodes.* **A. Klemm.** (Archiv f. Elektrot. 12. pp. 553–592, Feb. 29, 1924.)—A very exhaustive experimental investigation, using pairs of equal spheres of different radii from 0·6315 cm. to 3·145 cm. and also the same spheres with a plane plate. In some of the measurements with two spheres the voltage distribution was symmetrical, in another set one pole was earthed; unidirectional voltage was employed throughout. Two specially constructed high-tension voltmeters are described, one of which could be calibrated by using alternating voltages, produced by a step-up transformer. The breakdown field intensity in air was determined from the measurements, using W. O. Schumann's tables and formulæ; the values obtained for each pair of spheres in kilovolts per cm. were plotted as ordinates against the values of δ/r, where δ is the sparking distance, and r is the radius of the spheres; separate curves are shown for symmetrical voltage distribution, and for one pole earthed, with additional curves for sparking between sphere and plane. All the curves show the same general form, with high breakdown field intensity for small δ/r, falling to a minimum value as δ/r increases, rising again and then bending over towards the horizontal as δ/r goes on increasing. This minimum field intensity, and the value of δ/r at which it occurs, diminish at first rapidly, then gradually and almost linearly as the radius of the spheres increases. According to the simple theory the measurements with two spheres should be comparable with those with sphere and plate, so that, if $\delta_s = 2\delta_p$, $U_s = 2U_p$ and $E_s = E_p$, where δ_s is the sparking distance for the spheres, δ_p for sphere and plate, U_s the voltage at which discharge commences for the spheres, U_p for sphere and plate, and E_s and E_p are the respective field intensities; but this is not the case, and the sphere-plate experiments give higher values of U and E than the above. If the experimental minimum field intensities are compared with Schumann's theoretical values, approximate agreement is found in the case sphere-plate; but for two spheres the experimental values are higher than the theoretical, in the latter case the experimental values coincide approximately with the theoretical curve for the limiting value of the field intensity. For other conclusions drawn from the observations the original paper should be consulted. [See also the following abstract.] H. N. A.

1553. *The Minimum Breakdown Field Intensity with Spherical Electrodes.* **W. O. Schumann.** (Archiv f. Elektrot. 12. pp. 593–608, Feb.

29, 1924.)—The results of A. Klemm [see preceding abstract] are discussed, with relation to the theory of the author's book " Elektrische Durchbruchfeldstärke von Gasen " ; and it is shown that, assuming that the carriers of electricity consist of positive ions and electrons, there are certain differences between the curves, which are much greater than the possible experimental errors. It is necessary to consider the effect of the union of electrons with the gas molecules, forming molecular ions, the breaking up of these into molecules and ions, and the ionisation produced by collisions of the negative molecular ions with ordinary gas molecules. A very long and complicated equation is built up, giving the relations between the different quantities involved, and showing when the current becomes theoretically infinite, *i.e.* when sparking takes place. Simplified cases are worked out from this ; in the first no union of electrons is supposed to take place, in the second union takes place, but no ionisation is produced by the negative molecular ions, and they do not lose their electrons. Suggestions are made for separating the effects of the various changes, by varying pressure, temperature field intensity and sparking distance. So far the corresponding curves have not been experimentally determined. In the general expression obtained none of the magnitudes are simple functions of the field intensity, and it cannot be expected that the field intensity at breakdown will be independent of the sparking distance, as has sometimes been assumed. Cases can be imagined where the field intensity increases with the sparking distance, or where it passes through a minimum. Experiment shows diminution in some gases, increase in others. An increase is essentially connected with the fact that the ionising action decreases and does not increase when the field intensity increases. It is possible that in certain gases, in certain ranges, the union of electrons ϵ grows more quickly than the ionisation α ; particularly when at the same time the breaking up of the molecular ions κ diminishes. H. N. A.

1554. *Use of Braun Tube to Demonstrate the Detector Action of a Triode.* **W. Schmitz.** (Zeits. techn. Physik., 5. 3. pp. 94–96, 1924.)—A circuit diagram and description is given of an arrangement by means of which the action of a triode as a detector may be demonstrated. One coil influencing the Braun tube is included in the anode circuit, and a second, at right angles to the first, is included in a circuit tapped off the 50-cycle a.c. source which is used to affect the valve. The circuit including the second coil contains a choking coil in series with a non-inductive resistance, so that the phase can be adjusted within certain limits, and in this way the Braun tube can be made to give a stationary figure. Typical curves are reproduced. A. W.

1555. *Production of Undamped Electric Oscillations of Small Frequencies.* **R. Pohl.** (Zeits. f. Physik, 22. 5. pp. 303–304, 1924.)—This is an ordinary capacity inductance circuit with a frequency of about 1 second. Ordinarily such a system is heavily damped. Here, however, the pointer of the ammeter in the circuit is used to actuate a relay controlling the charging voltage. If the period of the needle corresponds with that of the condenser the system becomes self-acting, giving continuous vibrations. A. A. D.

1556. *The Change-over from Short Electric to Long Heat Waves.* **M. Lewitsky.** (Phys. Zeits. 25. pp. 107–109, March 1, 1924.)—The interval between short electric waves and the waves, which with the means at present in use, have been considered as pure heat waves, has been considerably diminished by the researches of v. Baeyer and Rubens [see Abstract 866 (1911)] and of v. Baeyer. However, no method has yet been described which has shown a direct passage of the former to the latter or *vice versa*. In the present preliminary communication experiments are described in which the method of electric generation is employed and by resonance in a suitable medium the shortest electric waves are shown as heat waves. A. E. G.

1557. *Stability of the Periodic States of the Triode Oscillator.* **W. M. H. Greaves.** (Cambridge Phil. Soc., Proc. 22. pp. 16–23, Feb., 1924.)—Periodic solutions of the equation $d^2v/dt^2 + f(v)dv/dt + w^2v = 0$, where $f(v)$ is a power series in v, have been developed by Appleton and the present author in a previous paper [Abstract 1202 (1923)]. The present paper is concerned with the stability of these periodic solutions. The criterion of stability obtained is the same as that already given by Appleton and van der Pol, but the method used possesses the advantage of showing that in the neighbourhood of a stable periodic solution the general solution tends exponentially to a periodic one, there being no possibility of small undamped vibrations about a periodic state. It is then shown that if a system represented by the above equation be started in any manner, it will eventually arrive in the immediate neighbourhood of one of the stable periodic states, and the previous result then shows that it will settle down exponentially into such a state. This is in agreement with experimental facts. A. W.

1558. *Measurements of the Fundamental Oscillations of Single-Layer Coils.* **W. Hofmeier.** (Ann. d. Physik, 74. 1. pp. 32–54, April, 1924.)—The problem of the free period of single-layer coils has been tackled both theoretically and experimentally without, however, a generally valid solution having been obtained. Previous work by Drude [see Abstract 1906 (1902)] is referred to, later the very comprehensive theoretical investigation by Lenz [see Abstract 1107 (1914)], and finally measurements by Geiss and Herweg. The present investigation reopens the subject. Coils whose lengths are great compared with their diameters give a fundamental oscillation determined solely by their forms. For short wide coils the distance apart of the windings comes into play. The formula given by Lenz for long coils affords values for the fundamental oscillation which deviate from those measured by a factor which increases from 1·11 to the limits of validity of the formula. For testing the Lenz formula for short coils, a determination of the fundamental oscillation from the coil form is not possible since the formula takes no account of winding distances. This oscillation, however, is found to be limited by the case of very large distances between the windings. The influence of wire insulation is unnoticeable in long coils but rises rapidly with the form factor. Turns between 100 and 20 increase the fundamental wave-length, but above 100 no further change was established. In the region $0\cdot06 < r/2l < 1\cdot0$, the fundamental oscillations are given by the formula, $\lambda = \pi \,.\, L \,.\, \sqrt{r/2l}$, which is valid for wire of 100 turns and distance apart 1·15. The values of the fundamental oscillation for free oscillating coils cannot be applied to closed oscillation orbits without further consideration. Tables of data are included. H. H. Ho.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1559. *Researches Made at the Laboratoire Central d'Électricité on the Properties of Aluminium.* **Jouaust.** (Soc. Franç. Elect., Bull. 3. pp. 663–669, Dec., 1923.)—An account is given of the results of researches in connection with the electrical resistance properties of pure aluminiums of French, American, and English origin. The results are given in *résumé* form; values of the resistivities at 20° C., ρ_{20}, the coefficient of variation of resistance with temperature, α, and the product of the two, $\alpha \cdot \rho_{20}$, are tabulated. The formula adopted for the resistance R_t at any temperature $t°$ C., is $R_t = R_{20}[1 + \alpha(t - 20)]$. Reference is made to the appreciably higher values of the resistivity found in the 1917 researches, and it is concluded that the value $\rho_{20} = 2820$ michroms per cm. cube at 20° C. should be adopted for rolled aluminium. The mean value found for α was 0·01147, with extreme values of 0·01125 and 0·01165, as compared with the N.P.L. mean value 0·01139. The mechanical properties of the aluminiums used are also given in this paper. A. W. J.

1560. *Electrical Resistivity of Metallic Products.* **L. Guillet.** (Soc. Franç. Elect., Bull. 3. pp. 641–662, Dec., 1923.)—The first part of this paper is a *résumé* of known facts, mainly concerning the effect on their resistance of alloying metals together. The second part deals with the resistance of aluminium. The effect of impurities (Fe and Si) on the resistivity is determined, both in the " as cast " condition after annealing for 30 mins. at 450° C. and after rolling, drawing, and extending, the worked material being studied before and after annealing. *Results*: (1) Impurities have a great influence on resistivity, silicon appearing to raise the resistance even more than iron; (2) thermal treatment has not much effect on annealed material; (3) work raises the resistivity, though the effect is smaller the purer the metal.

The third section of the paper deals with additions made to copper castings to cause soundness. The addition of boron carbide (in an impure form sold specially as a copper deoxidiser) is found to have no effect, but the addition of about 0·3 % Fe acts as a complete deoxidiser and gives perfectly sound castings. It has, however, the great disadvantage that it raises the electrical resistance. J. L. H.

1561. *Resistivities of some Granular Resistor Carbons.* **C. E. Williams** and **G. R. Shuck.** (Am. Electrochem. Soc., Trans. 42. pp. 181–193; Disc., 193–194, 1922.)—By means of an electric furnace, consisting of a rectangular column of resistance material contained in a refractory enclosure and supplied with current at the ends by two blocks of carbon, measurements are made of the resistance of different forms of carbon at different temperatures. Temperature measurements are made by means of protected thermo-couples embedded in the resistor. The factors investigated are the origin and type of carbon, size of particles, effect of preheating and content of volatile matter and the effect of added impurities. Increase of ash content when originally present raises the conductivity but only to a minor degree. Added impurities increase the resistance to a higher extent through increasing the contact resistance between the particles.

Charcoal containing 14 % of volatile matter showed no measurable conductivity. The resistance falls progressively on continued heating, due mainly to the elimination of the volatile matter, until all has been removed, when no further change is observed. Some of the decrease in resistivity may be due to the gradual graphitisation of the carbon and conversion of the mineral matter into more conductive carbides. The difference in resistivities of various types and sizes of carbon resistors is found not to be very large at 1000° C. to 1200° C. The temperature coefficient of resistivity is negative for all the forms of carbon tested up to 1000° C. or 1200° C., at which temperature it approaches zero and then becomes positive as the temperature increases further. This change is found to be more pronounced with graphite than with other forms of carbon. J. N. P.

1562. *Electrical Conductivity of Magnetite.* **E. Wilson** and **E. F. Herroun.** (Roy. Soc., Proc. 105. pp. 334–345, March 1, 1924.)—Five specimens of magnetite from different localities have been tested and the relation of the specific resistance to impressed voltage, temperature, compressive stress, and magnetisation determined. With one exception, all the specimens show a marked diminution of resistance with increasing impressed voltage. (The voltage range is up to about 2 volts.) The effects of heating are somewhat complicated by the fact that in general the resistance of a specimen is not the same before and after heating. But apart from this, there is for all specimens a considerable fall of resistance with increasing temperature, and a considerable increase of resistance due to cooling in liquid air. For instance, one specimen ("New York Original") had a resistance of 970 ohms in liquid air, about 1 ohm at atmospheric temperature and 0·15 ohm at 920° C. Tables are given showing (*a*) the effects of successive heatings and (*b*) the temperature coefficients of resistance over the range 10° C.–100° C.

Both transverse and longitudinal compressive stresses (about 890 kg./cm.^{2}) cause a diminution in the resistances of the specimens, the maximum effect being about 0·5%. Longitudinal and transverse magnetic fields also reduce the resistance, the amount of reduction increasing with the applied field. The fields range up to about 1700 c.g.s. units and the greatest diminution of resistance observed is of the order of 3%. A. A. D.

1563. *Conductivity Measurements with Cryolite-Alumina Mixtures.* **K. Arndt** and **W. Kalass.** (Zeits. Elektrochem. 30. pp. 12–17, Jan., 1924.)—The specific conductivity of cryolite-alumina mixtures up to 20 per cent. alumina content is measured in a platinum vessel; the value falls with increasing alumina content, and when extrapolated to 100 per cent. Al_2O_3, the value reaches zero. Therefore the alumina plays no part in conducting the electric current; the mixture should be regarded as a solution of cryolite in an indifferent medium, *i.e.* Al_2O_3, analogous to solutions of lime and silica in calcium chloride, and solutions of electrolytes in water. The equivalent conductivities of potassium fluoride, sodium fluoride, and cryolite were determined; the conductivity of cryolite is shown to be due to its sodium fluoride content. B. W. C.

1564. *The Hall Effect and Specific Resistance of Kathodically Deposited Films of Gold.* **S. S. Mackeown.** (Phys. Rev. 23. pp. 85–93, Jan., 1924.)—Measurements of the Hall coefficient in thin metallic films have been made by Moreau [Abstract 2398 (1901)], Wait [Abstract 209 (1923)], and Steinberg [Abstract 1208 (1923)]. Wait, using Ag films chemically deposited and of minimum thickness 23 $\mu\mu$, found the Hall coefficient independent of the thickness and the same as for the metal in bulk. The other observers found the coefficient dependent on film thickness. In the present investigation, Au films, prepared by kathodic sputtering, were used. The film thickness was obtained by dividing the mass per sq. cm. by the density of Au in bulk and varied from 10 $\mu\mu$ to 80 $\mu\mu$. The Hall coefficient was found to be 643×10^{-6}, independent of the thickness and of the same order as for Au in bulk. The range of field strengths was from 3 to 28 kilogauss and the current-density varied up to 10^6 amp./cm.^{2}. The value of the coefficient remained the same after varying heat treatment and during two months' exposure of the films to the atmosphere.

The electrical resistance of these films was also measured. Satisfactory results with films less than 10 $\mu\mu$ in thickness could not be obtained as the resistance was unstable. For the same reason determinations of the Hall coefficient on these thinner films were not reliable. For the thicker films, as the resistance is stable, it may be assumed that all particles are in contact. The conductivity K (ohm^{-1}) can then be expressed in terms of the surface density σ (gm. per sq. cm.) by $K = h(\sigma - \sigma_0)$. Except for very small values of σ the experimental results conform to this expression. The value of K is about 0·35 that of Au in bulk; $\sigma_0 = 20 \times 10^{-6}$ gm. per sq. cm., and taking the density of Au as 19 the average thickness of the particles is of the order 10^{-6} cm. L. L.

1565. *Passage of Currents through Loose Contacts.* **Angelika Székely.** (Zeits. f. Physik, 22. 1-2. pp. 51-69, 1924.)—*Résumé* of literature and full bibliography of (*a*) coherers and (*b*) passage across minute intervals. The author finds that between two metals bridges may be built up, which can be photographed; these bridges consist of the material of the anode, the kathode being without influence. Numerous analogies to the behaviour of coherers occur, and support the old hypothesis that in coherers bridges are formed. A. D.

1566. *Hall Effect and Thermoelectric Power.* **P. Raethjen.** (Phys. Zeits. 25. pp. 84-89, Feb. 15, 1924.)—Electron theories of metallic conduction which ascribe the process solely to negative electrons lead to the relation $e_{AB}/\log_e (R_A/R_B) = R/F$, in which e_{AB} is the thermoelectric power of metal A against B; R_A, R_B, the Hall coefficients for these metals; R, the gas constant ($8 \cdot 3 \times 10^7$ ergs per degree); F, the equivalent charge (9650 c.g.s. units).

To test this relation the author has carried out determinations of thermoelectric power and Hall coefficients for the metals Au, Ag, Pt, Cu, Al, Sn, and Pd. The metals were in the form of foil, supplied by Heraeus, technically pure, and thickness of the order 10^{-3} cm. The *Hall coefficients* were measured in a field of 10,500 c.g.s. units, the range of primary Hall currents being from 0·5 to 3 amps. The mean values determined from a number of specimens of each metal were:

Metal.	Ag.	Au.	Pt.	Cu.	Al.	Sn.
Hall coefficient $\times 10^4$	9·44	7·36	2·30	6·09	3·43	0·41

In the case of Pd the effect of occluded H on the value of this coefficient was also investigated. The amount occluded was expressed in terms of the change of electrical resistance of the Pd strip. The Hall constant for uncharged Pd is $7 \cdot 47 \times 10^{-4}$ and increases linearly with the H content to a value $7 \cdot 70 \times 10^{-4}$.

Measurements of the *thermoelectric force* of combinations of the metals were made with the cold junction at 20° C. and the hot junction at temperatures varying up to 50° C. Expressing the thermoelectric force in the form $E = (t_1 - t_2)[\alpha + 1/2\beta(t_1 + t_2)]$, the thermoelectric power at 18° (α_{18}) of various combinations is deduced. The ratio $e_{AB}/\log_e (R_A/R_B)$ does not show a constant value or follow any simple law. L. L.

1567. *Johnsen-Rahbek Effect.* **J. Wasik.** (Zeits. techn. Physik, 5. 1. pp. 29–31, 1924.)—Experiments with highly polished metallic surfaces tend to show that at the surface of metals there are formed layers, probably gaseous or fluid, possessing very great electrical resistance. These layers render it possible to obtain with metal surfaces analogous effects to those obtained by Johnsen and Rahbek with polished semi-conductors. Under the assumption that the conductivity of the layer between the polished metal surfaces depends on the potential difference applied between the two metals, the effect can be explained by the theory of Thomson's electrometer. The semi-conductors used in Johnsen and Rahbek's arrangement apparently only serve as an electrical resistance inserted in the circuit so that the current indicator is not damaged when the surfaces are short-circuited. A. W.

1568. *Thermoelectric Effects in Homogeneous Conductors.* **A. N. Shaw.** (Roy. Soc. Canada, Trans. 17. Sect. 3. pp. 195–196, 1923.)—The limitations of existing theories of the thermoelectric circuit are briefly referred to. The author has recently demonstrated the existence of the Seebeck effect in homogeneous conductors and has confirmed some of the contentions put forward by Benedicks. Unsymmetrical temperature gradients on either side of points of maximum or minimum temperature in a homogeneous conductor were found to produce small thermoelectric currents in copper, and large ones in iron, and it is tentatively suggested that these new effects may be correlated with existing thermoelectric data by ascribing the seat of the e.m.f. in the Seebeck effect, to regions where a temperature gradient is found. J. S. G. T.

1569. *The Properties of Dielectrics.* **G. L. Addenbrooke.** (Nature, 113. pp. 490–491, April 5, 1924.)—The present publication gives certain conclusions derived from a long study of the subject. Since capacity is energy reversibly stored at unit potential difference, and both resistance and the so-called "dielectric hysteresis" are energy dissipated or lost, much simplification is claimed by regarding dielectric actions in these two terms. After examining the actions in a number of diverse dielectrics, both in steady and alternating fields, those in clear thin sheets of celluloid were selected and results for these are discussed. It is found that the curve of energy dissipated is of the same general force as that giving the capacities, predicating an intimate relation, though the proportion of energy dissipated grows larger as the frequency is lower. By intensive drying it has been demonstrated that all the actions which have been so puzzling in dielectrics were wiped out, leaving only the fundamental capacity action outstanding, and this remaining capacity was found to change little with temperature, like the refractive index, though the eliminated actions all had large temperature coefficients. The latter point seems to coincide with the fact that the vapour pressure of water has a high temperature coefficient. Experiments are then described for finding the percentages of moisture present corresponding to the effects found, curves being included. These actions cannot be explained on the basis that water in dielectrics has a dielectric constant of about 80, and such moisture must be in a solid solution of electrolytic type. Apparently the surface tension of the dielectrics opposes a strong barrier to ions leaving the dielectric, and, in a steady field, these tend to accumulate near the surfaces. This slows down the action owing to their mutual repulsion, and is apparently the cause of the slowing-down of the action with time, a much studied and hitherto inexplicable phenomenon. With about 1/500th part of moisture present in the dielectric, such a large deflection on the electrostatic wattmeter can be obtained that a change of 1/200th part in this moisture would be seen readily. Consequently an amount of moisture so low as 1/100,000th part would produce a measurable effect. Ions must therefore have very active electrical charges. H. H. Ho.

1570. *The Power Loss in Condensers with Liquid Dielectrics.* **L. S. McDowell.** (Phys. Rev. 23. pp. 507–519, April, 1924.)—Using a variable test condenser with conical plates nickel plated, measurements for frequencies below 3700 were made with a special capacity bridge previously described by MacLeod, and for higher frequencies to 1,500,000 cycles by an ordinary resonance substitution method. *Castor oil, benzene, xylene, toluene, olive oil, paraffin oil, medicinal oil, "Bostonia," glycerine, and oil of turpentine* were studied; results are given for the first five. The power loss per unit voltage $R\omega^2C^2$ is approximately constant for benzene, xylene, and toluene, decreasing only from 202 to 184, from 102 to 90, and from 138 to 117 (all times 10^{-10} watts), respectively, as the frequency increased from 700 to 3500. This indicates that the loss is due chiefly to conductivity, but in some liquids, notably xylene, there is apparently a small additional loss which decreases with the frequency but which does not fit the equation for dielectric absorption. Castor oil and olive oil show a loss per unit voltage increasing with frequency, suggesting two leaky condensers in series. AUTHOR.

1571. *Dielectric Constant.* **R. Fürth.** (Zeits. f. Physik, 22. 1–2. pp. 98–108, 1924.)—Suggests a new method for finding the dielectric constant of conducting liquids of any conductivity, and for any order of frequency. The method is based upon finding the turning moment upon a perfect ellipsoid of revolution suspended within the liquid in question when an electric current is passed through the system. Measurements are to be undertaken. **Errata** (*ibid.* 23. 6. p. 417). A. D.

1572. *Piezoelectric Effects with Dielectrics.* **K. R. Brain.** (Phys. Soc., Proc. 36. pp. 81–92; Disc., 92–93, Feb., 1924.)—This paper describes experiments on the piezo-electrification of dielectrics. The materials examined are ebonite, glass, hornoid, sealing wax, rubber, celluloid, and hard paraffin. The results actually given nearly all relate to ebonite, but it is pointed out that the other materials behave similarly. Curves are given showing the relationship between the quantity of electricity produced and the applied load. There are very marked fatigue effects, considerable differences being observed between the results obtained on the same specimen in successive experiments. Examination of a cube of ebonite shows that different charges are developed on the various faces for the same load, suggesting a marked irregularity of structure. As the behaviour of crystals closely resembles that of dielectrics, it is concluded that these latter consist of crystals embedded in a surrounding matrix. This conclusion has been verified by X-ray examination. A. A. D.

1573. *New Form of Lutz String Electrometer.* **T. Wulf.** (Phys. Zeits. 25. pp. 109–111, March 1, 1924.)—Polemical with Lutz [Abstract 1968 (1923)], the author, claiming more especially to be responsible for the use of a tensile, bent quartz fibre in the construction of the string electrometer. J. S. G. T.

1574. *Thermoelectric Pyrometers.* **C. Bacchini.** (Elettrotecnica, 11. pp. 119–124, Feb. 25, 1924.)—A summary of the principles of thermoelectric measurement and a description of various pyrometers used in industrial practice. J. J. S.

1575. *Electrostatic Oscillograph.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 22. pp. 68–69, Feb., 1924.)—The instrument described is a modification of an electrostatic oscillograph invented by Taylor Jones. In the original instrument a thin phosphor-bronze wire is stretched parallel to a flat metal plate towards which it is attracted when a difference of potential is established between them. A small mirror attached by one edge to the middle of the wire and by the other to a piece of cork, indicates the motion of the wire. The free period $\alpha\sqrt{T/m}$ attains a minimum at a frequency of 5000, the limit being determined by the breaking stress of the wire. In the modified oscillograph two strings bridged by a small mirror are employed. One serves as a pivot for the mirror whilst the other, a flexible strip of galvanometer suspension, is deflected by the electrostatic forces. The free length of the strip is determined by two bridges 1½ cm. apart and the tension is varied by a lever mechanism. The instrument constructed had a natural frequency of 10,000 per second, and gave a deflection of 15 mm. at 30 cm. distance when a p.d. of 100 kilovolts was applied to the deflecting plates. A. B. W.

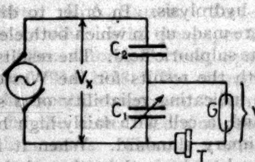
1576. *Measurement of Resistance Variations for Conductors not Obeying Ohm's Law.* **H. Greinacher.** (Zeits. Instrumentenk. 44. pp. 44–55, Feb., 1924.)—Wheatstone bridge methods and Poggendorff's compensation method of measuring resistance are discussed with reference to conductors not obeying Ohm's law. Formulæ are obtained from which the sensitivity of the two methods can be compared and the best arrangement selected for particular cases. A. W.

1577. *Measuring Small Capacities.* **H. Hermann.** (Zeits. Instrumentenk. 44. pp. 13–22, Jan., 1924.)—Discussion of a method for measuring small capacities, based on the capacity-reducing effect of a needle brought near a small sphere. A. D.

1578. *Measurement of Low-Frequency Amplification.* **R. L. Smith-Rose.** (Wireless World and Radio Rev. 13. pp. 699–702, March 5, and pp. 731–734, March 12, 1924.)—The author describes the arrangements in use at the National Physical Laboratory for tests on standard manufactured types of intervalve transformers. The apparatus makes use of a primary coil, excited by loose coupling to a valve generating audio frequencies, inside which two coils at right angles can be rotated about a common axis. Two valves, carefully paired, are used, and the switching arrangements are such that when one coil is connected to the grid and filament of the first valve, the telephones are included in the anode circuit and the second valve is not in use. When the second coil is connected to the grid and filament of the first valve, the telephones are inserted in the anode circuit of the second valve. By switching from one arrangement to the other and varying the position of the rotatable coils the telephone signals in the two cases can be made the same strength. From the position of the coils the two mutual inductances can be obtained by reference to the calibration curve, and the amplification is at once given. The results of tests thus carried out with resistance-capacity, choke-capacity, and transformer coupling are given. A. W.

1579. *Application of the Neon Lamp to the Comparison of Capacities and High Resistances.* **J. Taylor** and **W. Clarkson.** (Journ. Sci. Instruments, 1. pp. 173–182, March, 1924.)—This paper deals with the application of the "flashing" of the neon discharge tube to the measurements of capacities and high resistances. The relations both between the period of flashing and the resistance in the circuit, for a given capacity across the lamp electrodes, and the period of flashing and the capacity across the lamp, for a constant resistance, are linear to a high degree of accuracy. An extension of the method utilises beats between two neon lamp circuits flashing at high frequencies, for the measurement of small capacities. A. A. D.

1580. *Measurement of Peak Voltage with the Glow Tube.* **A. Palm.** (Zeits. f. Hochfrequenztechn. 23. pp. 18–20, Jan., 1924.)—The voltage V_g at which an inert gas-filled tube glows is used to measure peak voltages. If V_x is the voltage across the two condensers C_2 and C_1, and C_1 is increased until the tube just glows, which is indicated by the telephone receiver T, then the peak voltage is $V_x = V_g\left(\frac{C_1}{C_2} - 1\right)$. The whole success of the measurement depends upon V_g being a constant for the tube used, and not depending upon temperature frequency, external magnetic and electric influences, etc. These questions are considered in the paper, and it is shown that a tube with concentric cylindrical electrodes of aluminium, and with a neon-helium mixture at from 5–15 mm. Hg pressure, gives the best results. E. M.



1581. *Calibration of Cells for Conductance Measurements. Part III. Absolute Measurements of the Specific Conductance of Certain Potassium Chloride Solutions.* **H. C. Parker** and **Elizabeth W. Parker.** (Am. Chem. Soc., J. 46. pp. 312–335, Feb., 1924.)—In the measurements at 0° here described, the cells were embedded and thoroughly packed, in a thermostat, with finely shaved ice. It is suggested that the concentrations used for conductivity measurements be expressed in equivalents per cubic decimetre so that the present hybrid unit of equivalent conductivity may be avoided and values given in terms of the ohm^{-1}, cm.$^{-2}$, and gramme-equivalent. To denote equivalents per cubic decimetre, the term *demal* and the letter D are proposed.

For the absolute values at 0° of the specific conductivity of three potassium chloride solutions of concentrations D, 0·1 D and 0·01 D, prepared by adding 76·6276, 7·47895, and 0·746253 g. respectively of the salt to 1000 g. of water, both weighed in air, the values found are 0·065098, 0·0071295, and 0·00077284 ohms^{-1} cm.$^{-1}$; the value for the 0·1 D solution is suggested as a primary standard for the determination of cell constants in conductivity measurements. The values obtained by Kohlrausch and Maltby at 18° are found to be 0·145 % too high. The values given by Kohlrausch, Holborn, and Diesselhorst for potassium chloride solutions are shown to be 0·15 % too high on the average, but the relative values are also in error. Values are given for the new solutions for temperatures up to 30°, but for accurate measurements cells should be standardised at 0°. T. H. P.

1582. *The Effect of Various Preparations of Mercurous Sulphate on the Electromotive Force and Hysteresis of Weston Standard Cells.* **W. C. Vosburgh and M. Eppley.** (Am. Chem. Soc., J. 46. pp. 104–111, Jan., 1924.)—The solubility of a finely divided substance is dependent on the size of the particles and it has been thought that standard cells set up with mercurous sulphate sufficiently finely divided should have abnormally high electromotive forces. In order to test this, groups of cells were set up in which the size of the mercurous sulphate varied from about 240 μ down to 3 μ. It was found that the e.m.f. of the cells with a very finely grained mercurous sulphate was considerably higher than those with the coarser material. For example, cells with the sulphate varying from 5 μ to 110 μ showed a difference of 62 microvolts from the standard, whereas cells having the mercurous sulphate of a size 3 μ showed a difference of 147 microvolts. It may be claimed that the phenomenon is due to hydrolysis. In order to disprove this view some concentration cells were made up in which both electrodes were of mercury and the electrolyte was sulphuric acid. The results so obtained were in qualitative agreement with the results for the Weston cells. Low hysteresis cannot be taken as indicating reliability of a standard in low acid cells. On the other hand, a cell with fairly high hysteresis is the more reliable for use as a primary standard. When it is more important that cells should have low hysteresis than that their e.m.f. should agree with the established value, cells can be more acid and a fine-grain sulphate used. W. R. C.

ALTERNATING CURRENTS AND MAGNETISM.

1583. *Permeameter for Small Alternating Magnetic Fields.* **G. A. Kelsall.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 329–338, Feb., 1924.)—The usual method of determining the permeability of a material to small alternating forces is by measuring the inductance of a ring specimen by means of an inductance bridge. To avoid the disadvantages of this method, an apparatus is devised which is a special type of transformer with a single-turn secondary. The primary is wound on a laminated core, and the secondary consists of a copper shell or box enclosing the primary in the lower part and with an upper compartment to hold the ring or spool of wire to be tested. The secondary circuit is completed only when the circular cover or lid is put in place. The inductance of the primary, connected as one arm of an inductance bridge, is then measured, and the permeability of the material is calculated from this result. Assuming an equivalent parallel-branch circuit to correspond with the permeameter circuit, it is shown that L_3, the increase in inductance of the secondary when the test core is inserted, is given by $L_3=\{LL_1/(L_1-L)\} - L_s$, where L is the permeameter inductance measured on the bridge, L_1 is the inductance of the primary with open secondary, and L_s is the value of L when no test core is present. If the ring has mean diameter D, sectional area A, and the primary of the permeameter has N turns, then it is shown that $\mu = \{L_3D10^9/4N^2AK\} + 1$. The determination of the permeability of rings and of coils of wire on spools is illustrated by examples. The magnetising force is expressed by $H = FI/D$, where $F = 2N(L_1 - L)/5L$, and I is the current flowing in the primary. The permeameter can be calibrated at one frequency by using a core of compressed iron dust which has a constant permeability of 24·25 over a wide range of frequencies. G. E. A.

1584. *Paramagnetism of Iron in Ferricyanide of Potassium.* **Paule Collet.** (Comptes Rendus, 178. p. 937, March 10, 1924.)—The molecular susceptibility, χ_m, of ferricyanide of potassium in aqueous solution was measured, by the method of change of level, for solutions containing from 1·127 to 20·27 gm. of salt per 100 gm. of solution. The values found for χ_m varied from 1960×10^{-6} to 2258×10^{-6}; according to Pascal's measurements, the correction for the diamagnetism of the rest of the molecule $(CN)_6K_3$, amounts to 118×10^{-6}. The number of magnetons is 11·40 for the concentrated solution, and 10·91 for the most dilute. Weiss found from Honda's results that the solid salt contains 13 magnetons; the number for normal ferric salts is much larger, namely, 26 to 29. G. E. A.

1585. *Terrestrial Electromagnetic Variations.* **L. A. Bauer.** (Terrest. Magn. 28. pp. 129–140, Dec., 1923.)—The correlations in the paper are based on observations made at the Ebro Observatory, Tortosa, Spain, for magnetically quiet days during the period 1914–1918. The character of the diurnal and annual variations of the horizontal component indicates that only to a certain extent they may be the direct electromagnetic effects of the observed corresponding earth currents. There is a strong probability that the observed earth currents may be the combined result of a varying magnetic field and a varying electric field, as indicated by the rate of variation in terrestrial magnetism and atmospheric electricity. The correlation between the variations of earth currents and the time-gradients of atmospheric potential gradient is found to be higher than that for the time gradients of terrestrial magnetism, both as regards diurnal and annual variation [Abstract 121 (1923)]. W. A. R.

1586. *Normal Distribution of Terrestrial Magnetism over Siberia in 1910.* **B. Weinberg.** (Terrest. Magn. 28. pp. 113–123, Dec., 1923.)—The "normal" distribution of the magnetic elements over Siberia for 1910 is set out in tabular form. The table gives the values of the declination, inclination, and horizontal intensity, also the equivalent three rectangular components, at points situated at the intersections of a set of parallels of latitude drawn at intervals of 2°, with a set of meridians of longitude at intervals of 5°. The data employed comprised all available determinations (published and otherwise) made from 1820 to 1918. These were reduced to 1910 by means of the secular variation already determined by the author. The treatment of the data is described in some detail, and was such as to lead to a " normal " distribution, in which the influence of " local " disturbances is practically eliminated and in which the " regional " disturbances are much diminished. An examination of the available determinations has revealed great smoothness in the actual distribution of terrestrial magnetism over the explored part of Siberia, though certain anomalous areas, specified in the paper, have been found. A comprehensive list of references is given. M. A. G.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1587. *Cinematographic Radiography of the Human Heart.* **Comandon and Lomon.** (Comptes Rendus, 178. pp. 997–998, March 17, 1924.)—Difficulties of the above are pointed out. Progress in X-ray technique has allowed 16–18 images per second to be obtained, by methods originally used by the authors in 1911, and by use of improved screens of calcium tungstate. To obtain a sufficient number of exposures per second, secondary currents of 150–300 milliamps. are needed. Using 250 milliamps. at 80 kilovolts, *via* a Coolidge tube, the first five images obtained were clear, but the intensity then falls rapidly and renders the image unreadable. After the tube has so been used for 1–2 seconds, the antikathode is pitted and volatilised metal is deposited upon the glass walls. It is said a pure electron discharge is no longer obtained, and it would appear the bombarding electrons no longer reach the solid antikathode, but only the layer of vaporised metal in front of it.

By means of varying voltages the cinematographic method has been applied to find the optimum voltage to excite best screen fluorescence. The intensity does not appear to vary much between 65–85 kilovolts, but, in the region of 100 kilovolts, the intensity becomes rapidly double owing to the excitation of the tungsten K radiation, which occurs at 70 kilovolts, but does not become intense below 70 kilovoltes. At 100 kilovolts fifty images have been obtained in 3 seconds with 150 milliamps., but modifications of tube and screen are necessary to obtain results more easily. B. J. L.

1588. *Recent Advances in X-Ray Technique.* **M. A. Codd.** (El. Rev. 94. pp. 566–569, April 11, 1924.)—A general article upon X-ray technology, which contains results obtained by means of a Duddell oscillograph during investigations upon the discharge due to transformers and coils. As is generally known, these show that only the peak of the voltage curve is effective in producing X radiation.

The article also deals with interrupters, Dessauers cascade transformer tubes, high-tension leads to obviate brush discharge, protection, methods of measuring dosage and penetration, but adds nothing novel. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1589. *Solubility of Helium and Hydrogen in Heated Silica Glass and the Relation of this to the Permeability.* **G. A. Williams** and **J. B. Ferguson.** (Am. Chem. Soc., J. 46. pp. 635–639, March, 1924.)—Experimental details are given of the determination of the solubilities, which are found to be, for H in silica glass at 515°, $a = 0 \cdot 0092$; at 445°, $a = 0 \cdot 0098$; He in silica glass at 515°, $a = 0 \cdot 0101$; at 445°, $a = 0 \cdot 0103$; He in Pyrex glass at 515°, $a = 0 \cdot 0083$, where a is the number of c.c. of gas (under standard conditions) dissolved in 1 c.c. of glass when the saturating pressure is one atmosphere. The comparatively small difference in the solubility of the two gases does not clear up the discrepancy between the observed rates of effusion and the rates expected from the respective densities according to the law of Graham and Bunsen. The relation between temperature and permeability is shown to be similar for many of the cases which have been investigated. A. B. C. L.

1590. *Behaviour of Gases in Contact with Glass Surfaces.* **D. H. Bangham** and **F. P. Burt.** (Roy. Soc., Proc. 105. pp. 481–488, April 1, 1924.)—The sorption values for CO_2 in contact with fine glass-wool have been measured for a range of pressure from 0·6 cm. to atmospheric. Initially the glass-wool was cleaned and dried *in situ*. The gas was then admitted and the subsequent fall of pressure in relation to the time determined. For any given pressure the result may be given in the form $S^m = ht$ where s is the volume of gas adsorped. The index m is a function of the pressure, having larger values at higher pressures. Experiments with other gases yield very similar values for the index m. Desorption experiments are also described and for short times after each pressure reduction the quantities desorped are represented by $r \log_{10} \zeta = \log_{10} t + k$ where ζ is the quantity desorped in any given step at time t after the reduction of pressure. The desorption results are somewhat irregular.

A. A. D.

1591. *Rate of Absorption of Water by Rubber.* **D. H. Andrews** and **J. Johnston.** (Am. Chem. Soc., J. 46. pp. 640–650, March, 1924.)—The absorption of water by rubber was investigated. A weighed sheet of rubber was immersed in water for a period of time, taken out, wiped and reweighed. The weight increased rapidly at first, then more and more slowly, finally reaching a limiting value. The measurements of the rate of absorption of water by a series of sheets of rubber have shown that the fractional saturation of the sheet as a whole is a function of t/a^2, when t is the period of immersion and a the half thickness of the sheet. The results, when properly plotted, all lie on a single curve. This fact is in substantial accord with the theory of diffusion, and the behaviour of thicker sheets, in which substantial saturation is attained only after an interval of years, can be predicted from observation of thin sheets for a period of weeks. The information is of importance in the behaviour of insulation, since the water content of a material has a large effect upon its insulating properties. F. J. B.

1592. *A Method for Studying the Rapid Absorption of Gases by Liquids.* **P. G. Ledig** and **E. R. Weaver.** (Am. Chem. Soc., J. 46. pp. 650–657, March, 1924.)—A simple form of apparatus suitable for the detailed study of absorption from small bubbles of gas by liquids is described, and details given of the application of the device to the study of absorption from bubbles of carbon dioxide by a solution of sodium hydroxide. A bubble of carbon dioxide of known volume is blown beneath mercury and ascends into the solution of sodium hydroxide, where absorption occurs in a closed system, open to the air through a capillary tube only. Contraction of the bubble due to absorption produces motion of the thread of solution contained in the capillary tube, and this motion is recorded photographically. It is shown that the absorption of carbon dioxide by a solution of sodium hydroxide comprises three stages. The first is characterised very rapid absorption at the newly formed liquid-gas interface. An equilibrium condition ensues during which the diminished rate of absorption is controlled by diffusion of the reagent to the interface and of the reaction product away from the interface. The third stage begins when the diluting gas, *e.g.* air, invariably present in the bubble, starts to diminish the rate of diffusion of carbon dioxide to the interface. Particulars are given of an investigation of possible effects due to variation of concentration and viscosity of the solution, and the presence of an inert gas, upon the rate of absorption [see Abstract 195 (1924)]. J. S. G. T.

1593. *Gels and Theory of Adsorption.* **N. E. Gordon.** (Science, 58. pp. 495–497, Dec. 14, 1923. Paper read before the Am. Assoc. for Advancement of Science, Dec., 1922.)—From the results of experiments on silica gel it is concluded that there are four different types of adsorption from solution: (1) Chemical adsorption, which follows the mass law; (2) exchange adsorption, in which one ion is adsorbed at the expense of replacing an equivalent amount of a second ion; (3) partition ratio adsorption, in which the adsorption obeys Henry's law, and (4) electronic adsorption, in which the adsorbed material seems to be held by a secondary valency. Two or more of these types may exist in combination.

T. H. P.

1594. *Diffusion in Gels.* **C. T. Mann.** (Roy. Soc., Proc. 105. pp. 270–281, March 1, 1924.)—Chemical analysis of successive layers, as a means of obtaining the necessary data for the calculation of coefficients of diffusion, yields on the whole lower results than are obtained by the indicator method. The results with NaCl are similar to those of Öholm (Z. phys. Chem. 50. 309, 1905 and Nobel Institute, vol. 2. no. 30. 1913). Stiles and Adair's explanation (Biochem Journ. 15. 620–628, 1921) that the indicator method reveals the more rapid travel of free ions as contrasted with that of total salt is confirmed by conductivity measurements.

A. D.

1595. *Electrically Exploded Wires in High Vacuum.* **S. Smith.** (Nat. Acad. Sci., Proc. 10. pp. 4–5, Jan., 1924.)—Wendt and Irion have reported the presence of helium in tubes in which tungsten has been electrically exploded [Abstract 94 (1923)]. As there is some doubt as to the origin of the helium in these experiments (that is, as to whether it is occluded, or produced by the disintegration of the tungsten) the present work was undertaken. The wires were exploded in an extremely high vacuum, and in general the tubes, after the explosion, were non-conducting up to voltages of 60,000, the highest used. In cases where a discharge could be passed there was no trace of helium. Similar observations were made with wires of lead and aluminium. A. A. D.

1596. *New Light Filter for the Detection of Potassium.* **L. W. McCay.** (Am. Chem. Soc., J. 45. p. 2958, Dec., 1923.)—For cutting off sodium light, etc., in order to allow of the detection of potassium, use may be made of a solution of 310 g. of crystallised chrome alum in 1 litre of water, the solution being placed in bottles of square prismatic form closed with wooden stoppers. This solution absorbs completely not only sodium light, but also that of lithium, strontium, calcium, and barium; rubidium and cæsium flames are visible through it, but these metals occur rarely and only in small amounts. T. H. P.

1597. *Chemiluminescence.* **A. Petrikaln.** (Zeits. f. Physik, 22. 1-2. pp. 119-126, 1924.)—In 1912, Centnerszwer and the author succeeded in finding (Zeits. phys. Chem. 80. 235, 1912) an extremely faint line spectrum in the ultra-violet up to 238 $m\mu$, on the slow oxidation of white phosphorus. The author now finds this to be a spectrum of narrow bands. This is traced to emission from P_2O_5. The formation of P_2O_5 is visible under the microscope. Ionisation phenomena are present; but the energy evolved is almost wholly in the form of heat. A. D.

1598. *Theory of Emulsification.* **P. Finkle, H. D. Draper,** and **J. H. Hildebrand.** (Am. Chem. Soc., J. 45. pp. 2780-2788, Dec., 1923.)—The present condition of the theory of emulsification is outlined, the types and relative stabilities of emulsions formed with the aid of various soaps being explained by means of the theory of orientation of the soap molecules in the interface. The curvature of the film of soap adsorbed at the interface is more convex towards the water, yielding more stable emulsions of the oil-enclosed type, the larger the metallic atom in the soap. As the number of hydrocarbon chains attached to a single metallic atom increases (with the valency of the metal) the curvature is reversed, becoming strongly convex towards the oil phase with soaps of the tervalent metals, aluminium and iron, which yield the most stable emulsions of water and oil. Experimental data on the type and relative stabilities of emulsions of various liquids with water show that the transition from the most stable oil-enclosed to the most stable water-enclosed emulsion for both stearates and oleates follows the order: Cæsium, potassium, sodium, calcium, silver, magnesium, zinc, aluminium, iron; this order is in accord with the valencies and atomic diameters of the metals, as interpretated by the orientation theory. It is suggested that the type of emulsion produced by a solid powder is determined by the angle of contact of the interface with the solid. In order that the powder may remain in the interface the angle must be finite, and unless the angle is 90°, the interface will be on one side or the other of the points of contact of the particles, and its tension will cause the film to be concave on that side. T. H. P.

1599. *Dissociation of Chlorine and of Hydrogen into their Atoms. Part I. Dissociation of Chlorine.* **K. Wohl.** (Zeits. Elektrochem. 30. pp. 36-46, Jan., 1924.)—The values of the heat of dissociation of chlorine determined by different methods by Pier (113,000 cal. at constant volume), Trautz (70,000), and v. Wartenberg and Henglein (54,000) differ widely. The author makes use of the method of Pier and of Pier's later improvement of his membrane bomb manometer. Like v. Schmidt (dissertation, Berlin, 1921), he determines the explosive pressure of HCl mixtures, deducing the temperature of the explosion from the maximum pressure and the heat capacity of the mixture. As inert gas to mitigate the explosion, he uses an excess of chlorine. The bomb of 10 litres capacity was enamelled inside to minimise the adsorption of HCl vapours by the walls. The membrane is a corrugated steel disc between steel rings, 5 cm. in diameter. The heat losses are relatively low when the temperatures are high, and did not exceed 0·3 %. Each observation gives an equation with two unknown quantities, the molecular heat of HCl and the heat capacity of the dissociating chlorine at the temperature of the explosion. The mean molecular heat of chlorine Cm_{Cl_2} at constant volume between 291° and 1335° C. abs. is found to be 6·83 cal., the heat of formation of 1 mol. of HCl at ordinary temperature being 22,000 cal. Up to 2000° the variation of Cm_{Cl_2} is given by $4 \cdot 963 + (E_T - E_{291})/(T - 291)$, where E is the energy of the atomic oscillation in the Cl molecule, E calculated as an Einstein function being $\beta\nu = 902$. The heat of dissociation of chlorine at absolute zero is $57{,}000 \pm 2000$ cal.

Part II. Dissociation of Hydrogen (*ibid.* pp. 49–62, Feb., 1924).—The heat of dissociation of hydrogen lies, according to Franck [Abstract 648 (1920) and later experiments], between 80,000 and 100,000 cal. (method of impact ionisation). Langmuir (heat conductivity of hydrogen at high temperature) found 84,000 cal., but had to make certain assumptions in his experiments with tungsten lamps. The author uses the method described in Part I, exploding in this case chlorine with an excess of hydrogen, this being preferable to H O explosions on account of the high molecular heat of water-vapour. HCl having a low specific heat may also be added to the mixture. Oscillations appear in the pressure curve of the hydrogen mixtures above 2000°; above 2530° their amplitudes became great owing to the development of a detonation wave. When HCl was added to the mixture, the oscillations were less marked. Each experiment gives an equation with four unknown quantities: Cm_{HCl}, D_{HCl} (the heat consumed in dissociating HCl and in dissociating the hydrogen and chlorine molecules into their atoms), Cm_{H_2} and D_{H_2}; the final values have to be found by trial. For the range $T = 1950$ to 2580° Cm_{HCl} is $(E_T - E_{291})/(T - 291)$, where $\beta\nu = 3420$; E_{291} is practically zero. In the analogous formula for Cm_{H_2}, $\beta\nu = 5340$; this value is applicable above 1000°; at lower temperatures the disregard of the decrease in the heat of rotation becomes noticeable. The heat of dissociation of hydrogen at abs. zero is $U_0 = 95{,}000$; at T the value is given by $U_{H_2} = 95{,}000 + 0 \cdot 993T - E_{H_2} \pm 2000$ cal. In view of the uncertainty of the chemical constant of monatomic hydrogen the heat of dissociation of hydrogen may lie between the limits 75,000 and 105,000 cal. H. B.

1600. *The Surface Energy of Crystals and their Forms.* **M. Yamada.** (Phys. Zeits. 25. pp. 52–56, Feb. 1, 1924.)—This is a supplement to the author's previous paper on the subject [see Abstract 336 (1924)], and goes more closely into the method of calculation of the surface energy of inclined surfaces in crystals. The mathematical difficulties involved in the problem are dealt with. H. N. A.

1601. *The Shapes Arising from Crystals with Curved Surfaces after Etching.* **R. Gross, F. Koref, and K. Moers.** (Zeits. f. Physik, 22. 5. pp. 317–321, 1924.)—Previous work by Becke, Johnson, Schnorr, and Poppe, is first referred to, these authors having described dissolution and growth phenomena on plane-surfaced crystals, and established thereby that a definite velocity exists for each crystal and is capable of measurement. Gross then applied the method to crystals possessing curved surfaces and obtained similar results. He then showed that from given physical conditions the shape which the crystal would assume during the solution process could be theoretically constructed. The remarkable result was deduced that the contour of concave crystals is formed of surface elements having the least velocity of growth, while convex crystals are generated by the most rapid. The relationships were established for gypsum [Zeits. f. Krist. 57. 145, 1922]. The present investigation seeks to afford support to the Gross construction methods and consequences by a study of metallic crystals. For this purpose a tungsten thread was etched and the surfaces examined by a combination of Röntgenometric and goniometric methods. Experimental details are included. H. H. Ho.

1602. *Osmotic Pressure of Electrolytes of Large Molecular Weight.* **E.** and **H. Hammarsten.** (Arkiv f. Kem. Min. o. Geologie, Stockholm, 8. No. 27. pp. 1–16, 1923. In German.)—The investigation deals with some compounds of physiological interest which show an osmotic anomaly of the same type as Congo red, which gives a normal osmotic pressure in spite of strong electrolytic dissociation. Thus in one of the cases studied the osmotic pressure was about half the value calculated from conductivity measurements as compared with about two thirds for Congo red, and certain similar dye-stuffs. T. M. L.

1603. *Space-Filling in Crystals.* **F. A. Henglein.** (Zeits. Elektrochem. 30. pp. 5–12, Jan., 1924. Paper read before the Deut. Bunsen Gesell., Hanover, May, 1923.)—According to Kopp, the molecular volumes of organic liquids at their boiling-points are approximately equal to the sums of the atomic volumes of their constituents. To obtain corresponding states, crystals should be compared at absolute zero. But the ratio molecular heat/expansion coefficient is, according to Grüneisen [Abstract 1105 (1918)], for most solids fairly constant so that comparison at ordinary temperatures is permissible. For groups of compounds of the same crystal structure regularities as to molecular volume have been pointed out by Grimm, Biltz, and the author [Abstract 2149 (1922)]. The author extends these considerations with respect to the ions. When the molecular volumes of the alkali chlorides are plotted against those of their sulphates and other salts, linear relations are found, provided the substances have similar crystal structures. The ions must therefore be of constant size, dependent upon their sequence in the periodic table. If unit volumes are arbitrarily assigned to the sizes of the ions of lithium and chlorine, then the sizes of the ions of the other alkali metals and halogen ions can be deduced from the linear relations, and these values are shown again to be in linear relation to the respective atomic vol of the elements in the free state. These arguments are applied to v groups of salts and of crystals (cubic, face-centred, and space-c rhombic, monoclinic, etc.). There are deviations from the regu magnesium, for instance, stands closer to zinc and cadmium in m

than to the metals of the alkaline earths. The author's periodic table of the elementary ions consists of 7 vertical columns and 6 horizontal rows. The columns show the natural families, the inert gases being in the fourth column. In the rows the ions are arranged in the sequence of their atomic numbers; all the ions of a row have the same number of negative electrons but the positive charges increase from left to right. Thus the second row is: N(− 3), O(− 2), F(− 1), Ne(0), Na(+ 1), Mg(+ 2), Al(+ 3), Si(+ 4).
H. B.

1604. *Structure of Solid Solutions.* **A. Westgren** and **G. Phragmén.** (Nature, 113. pp. 122–124, Jan. 26, 1924.)—The view that atoms of similar kind replace each other in a common lattice was confirmed in 1917 by Vegard, who showed that, in alkali halides forming mixed crystals, the lattice dimensions of the latter lay between those of pure components.

By making use of a precision camera to measure the angles of the most deviated interferences from an illuminated crystal powder, the authors have examined a high-carbon steel, quenched in water from 1100° and containing mainly austenite (a solid solution of carbon in γ-iron), and also a low-carbon steel quenched at 750° and consisting of a mixture of martensite (α-iron and carbon) and austenite. The most important feature shown by the plate is that the lines corresponding with the γ-iron have not the same position in the two photograms, there being thus a difference between the lattice dimensions. The face-centred elementary cube of the steel quenched at 1100° has the edge 3·629 Å., whereas the corresponding value for the other steel is only 3·601 Å. This change in the dimensions is scarcely explainable except by the difference in the carbon contents of the two austenitic phases, and the increase in size of the lattice with the proportion of carbon, in spite of the smallness of the carbon atoms in comparison with the iron atoms, indicates that in this case the solid solution is not formed by simple substitution. Calculation of the density of a homogeneous austenitic manganese steel on the assumption that the lattice is formed only by iron and manganese atoms between which the carbon atoms are distributed uniformly gives a result in exact agreement with the experimental value.

The copper lattice is not changed in type by the dissolution in the metal of less than 8 % of aluminium, but it increases in size with rising content of aluminium. With these alloys the experimental values for the densities lie on the density curve calculated from the lattice dimensions on the assumption that three copper atoms in the lattice are replaced by two aluminium atoms, but it is still not understood how this unusual form of substitution can be brought into accord with the cubic symmetry of the atomic arrangement. The groups of atoms present in the elementary cube of the series of solutions examined correspond very nearly with the formulæ, $Cu_{36}Al_{16}$, $Cu_{33}Al_{18}$, $Cu_{30}Al_{20}$, and $Cu_{27}Al_{22}$. Zinc-copper alloys appear to be formed by simple substitution of an atom of one metal for an atom of the other in the lattice. T. H. P.

1605. *Photochemical Properties of Cuprous Oxide.* **A. D. Garrison.** (J. Phys. Chem. 28. pp. 279–284, March, 1924.)—This is a continuation of the work referred to in Abstract 1325 (1924). The conductivity of a suspension of cuprous oxide in pure water is not influenced by white light. It was found that conductivity of a suspension of copper coated with a thin layer of cuprous oxide is increased by white light. The system Cu_2Cl_2–Cu_2O–Cu–H_2O has a higher resistance in the light than in the dark. W. R. C.

1606. *Corrosion of Various Aluminium Alloys by Salt Water.* **D. Basch** and **M. F. Sayre.** (Mech. Engineering, 46. pp. 199–201; Disc., 201–205, March, 1924.)—The corrosion of various alloys of aluminium containing copper, manganese, zinc, magnesium, iron, silicon and nickel, was investigated. The alloys were rolled, sand cast, and die cast, and in some cases they were heat-treated. The alloys were exposed to salt spray in a specially designed apparatus and were weighed at intervals of three or four days. The rate of corrosion was judged by four factors: Appearance, gain in weight, depth of corrosion and percentage loss of strength. The results showed that high tensile strength alloys were not the most resistant to corrosion, but that silicon alloys with a relatively low tensile strength had the highest resistance to corrosion. F. J. B.

1607. *On Two Attempts to Replace the Theory of Ions by a Theory Based on the Molecular State of Water.* **V. Auger.** (Comptes Rendus, 178. pp. 330–332, Jan. 14, 1924.)—The author maintains that the views of Armstrong (*ibid.* 176. p. 1892, 1923) and of Kling and Lassieur [Abstract 339 (1924)] are not in accord with the laws of chemical equilibrium. He also criticises their views on the ground that they cover a smaller range of phenomena than the theory of ions which they attempt to displace.
T. M. L.

1608. *The Activity Coefficients of Ions in Very Dilute Solutions.* **J. N. Brönsted** and **V. K. la Mer.** (Am. Chem. Soc., J. 46. pp. 555–573, March, 1924.)—The osmotic and activity coefficients for a salt in a solution of mixed electrolytes of differing valency types are given by

$$1 - \phi = az_1z_2\sqrt{\mu} \text{ and } - lnf = 3az_1z_2\sqrt{\mu}$$

where ϕ and f are osmotic and activity coefficients, z_1, z_2 are valencies of the ions of the salt, μ is the "ionic strength" of the solution, a is a constant involving the temperature and the dielectric nature of the solvent. These thermodynamically correlated expressions are deduced from previous work [see Abstract 230 (1922)] by introducing the conception of "ionic strength" and assuming that the coefficients in very dilute solutions are determined solely by electrostatic forces. These relations, which are partly empirical, may be extended to more concentrated solutions, giving results in good agreement with the theoretical considerations of Debye and Hückel. Experimental verification is obtained by measuring the change of solubility of sparingly soluble electrolytes (chiefly complex ammoniacal compounds) for a range of concentrations from 0·02 M to 0·00005 M. The data obtained confirm the equations developed by the authors for these "ideal" conditions. B. W. C.

1609. *Chromising.* **F. C. Kelley.** (Am. Electrochem. Soc., Trans. 43. pp. 351–368; Disc., 368–370, 1923.)—The method of chromising iron consisted of packing the material to be treated into a mixture of alumina and chromium. The mixture contained 45 % alumina, and 55 % chromium by weight, and was packed into an iron tube and then heated to 1300° to 1400° C. in hydrogen, in vacuum or in some neutral atmosphere. The time of heating depended upon the penetration and concentration of chromium desired. The quantities of chromium taken up were determined by weighing the iron before and after chromising, the heating being continued for 3 hours. The samples were ½ × ½ × ½ to ⅝ in. three samples used for each run. The gain in weight amounted to as much as 4·5 % in 3 hours at 1350° C., the chromium penetrating to a depth of 0·352 mm. It was shown that chromised iron was extremely resistant to corrosion, especially when used as turbine buckets. After a year of service side by side, an unchromised nickel steel bucket had its edge entirely corroded and eroded away, and the face badly corroded, whereas the chromised bucket was in perfect condition. The effects of heat treatment, carbonising and the chromising of other metals is also discussed. F. J. B.

1610. *Effects of Rate of Cooling on the Density and Composition of Metals and Alloys.* **R. C. Reader.** (Inst. of Metals, J. 30. 2. pp. 105–109; Corres. 109–113, 1923.)—The author in his introductory remarks lays stress upon the great importance of the subject, and notes the serious attention now being given to it by metallurgists. It is recognised that the cooling rate of an alloy may determine both its physical and mechanical properties. Reference is made to previous work of the author in which it was shown that the useful mechanical properties of 10 % aluminium copper alloys are adversely affected by a slow rate of cooling. The present notes deal with the numerical values obtained, showing the effect upon density and composition throughout the mass of metals and alloys due to different rates of solidification. The results are divided into two parts, namely: (1) Effect of rate of cooling on density, and (2) effect of rate of cooling on composition throughout the mass. The pure metals tested included tin, lead, zinc, and aluminium and the results obtained indicate that their densities are not affected by rate of solidification, if poured within a suitable range of temperature. The alloys chosen were binary ones of aluminium, zinc, and tin, respectively with copper. The conclusions reached from the results of the tests were that those alloys which solidify at a constant temperature are not affected as regards density by the rate at which they solidify. Alloys which solidify over a range of temperature give a lower density in the interior of the bar, when chill cast, while other alloys are not so affected. Alloys which solidify through a range of temperature are inversely segregated on rapid solidification—that is, are richer on the outside in the component of the lower melting-point and richer in the centre in the higher melting-point component, while the alloys which solidify at a constant temperature are homogeneous throughout. The discussion to this paper indicated a general agreement of the results of other authorities with the authors. A. W. J.

1611. *Plastic Deformation of Crystals.* **E. Schmid.** (Zeits. f. Physik, 22. 5. pp. 328–333, 1924.)—Although the pressure relationships which occur during the plastic deformation of single crystals have been repeatedly discussed, the author finds a fresh viewpoint in the light of a recent paper by Siebel [see Abstract 681 (1924)]. The plastic extension of a crystal proceeds by a bending-slip along the important crystallographic planes [see Abstract 991 (1923)], and an experimental substance has been chosen of a circular cylindrical crystal which only suffers slip along a range of slip surfaces whereby it passes into flat bands through the extension. On the assumption that at the beginning of the extension the friction in the slip surface remains constant in the direction of slip during the whole course of the extension, the equation of the extension curve has been derived. From the calculated decrease of load it follows that the rigidity of polycrystalline test pieces cannot be explained by the different orientation of the single grains during the extension. It then follows, from the study of the actual and theoretical curves, that the assumption of a constant slip friction is not justified. The crystal exhibits considerable internal rigidity during deformation which appears as a pressure increase.

H. H. Ho.

1612. *Acceleration of the Landolt Reaction by Bromides and Chlorides.* **A. Skrabal.** (Zeits. Elektrochem. 30. pp. 109–124, March, 1924.)—Continuation of previous researches by the author (*ibid.* 28. pp. 224–244, 1922), now joined by R. Rieder, on the reduction of iodate solution by means of sulphurous acid (the Landolt reaction) and the acceleration of this reaction by the presence of other halogen compounds, especially chlorides and bromides. The total result of the reaction may be expressed by the equation $IO_3' + 3SO_3' = I' + 3SO_4''$, that is to say, the final products are iodide and sulphuric acid. In the presence of Br' or Cl', however, there are altogether seven simultaneous reactions proceeding at different rates which the author attempts to determine. He refutes the criticism of Dhar, agrees on the whole with Dushman, and assumes in his discussion, on the lines of Arrhenius and Bodenstein, of the general kinetics that the constant k' of the velocity of reaction consists of two terms, K strongly dependent upon temperature, and the kinetic term proper k, varying but little with temperature. Chemical reactions follow a definite time law over only limited ranges of concentration and velocity. When sodium chloride and potassium bromide are added, they have also a slight retarding (not accelerating) effect like all neutral salts, or, as the author prefers to say, like all strong electrolytes; this he tests by experiments with sodium nitrate. But the accelerating effect of Br' is enormous, that of Cl' much less marked; the effect of the addition of I' may be either accelerating or retarding. H. Wastl's suggestion, that the resulting SO_4'' take part in the reaction according to the mass law, is criticised; the mass law is not applicable, but the SO_4'' ions act by catching $H^{\cdot}$ ions and forming HSO_4'. When Wastl in biological experiments concerning the influence of organic catalysts on the Landolt reaction further objects that owing to "ionic antagonism" the combined accelerating effect of two catalysts is not equal to the sum of the single effects, that is, of course, in accord with general kinetic principles; organic reactions may, moreover, be highly complex. The author's tables of constants are only to apply to conditions far remote from equilibrium conditions. The general kinetics of the reduction of halogenate are given by $[IO_3'][H^{\cdot}]^2[X'][Y']$, where X and Y indicate the same or different elements of the group Cl, Br, I.

H. B.

1613. *Variation of the Rate of Combustion of Hydrogen-Air Mixtures with Pressure and Temperature.* **H. Mache.** Experiments by **A. Nägel.** (Akad. Wiss. Wien, Ber. 132. 2a. No. 5–6. pp. 215–231, 1924.)—The author supports the theory due to himself and L. Flamm [Abstract 690 (1918)], by examining the data which Nägel [Abstract 504B (1908); Mitt. über. Forsch. Ab., 1907] obtained with a spherical bomb of 33·51 capacity provided having a flat spring indicator and with a photographic film travelling at 3 m./sec., so that the diagram attained a length of 92 mm. In the one case, for which fuller particulars are given, the mixture saturated with water vapour contained 21·4 % of hydrogen at an initial pressure of 2·5 atmos. abs. and 288° K.; the maximum pressure rose to 18·223 atmos. and the temperature to 2350° K.; the scale of abscissa was 1 mm., equal to 0·0003127 sec.; the pressure rose first slowly and then rapidly to its maximum. The initial pressure was varied between 0·5 and 2·5 atmos.; the other conditions changed but little. Ignition was effected at the centre of the sphere to avoid catalytic effects of the wall. The pressure observed is corrected by means of the mixture ratio, the heat of combustion and the value for the specific heat of the combustion products which Pier found in experiments with a bomb of the same size. In their formula Mallard and le Chatelier had assumed that the rate c' with which an area of combustion advances with respect to the unburnt mixture depends upon the volume of gas that the quantity of heat W coming from that area can raise to the ignition temperature per second, and that this heat current is independent of the initial temperature. In view of Cassel's observation (Ann. d. Physik, 51. p. 685, 1916), that the rapid rise to the high temperature of combustion only sets in at temperatures considerably above the ignition temperature, the author submits that W cannot be taken as constant. Calculating also γ, the mass of gas mixture burnt per sq. cm. of combustion area per second, he deduces that γ increases as the temperature rises to about 100° C., but remains fairly constant afterwards. But γ changes much with the pressure, since $\gamma_p = \gamma, p^n$. At the maximum pressure observed of 17·5 atmos. γ had the value 5·69; the maximum value of n, *i.e.* 1·36, had then already been passed and had diminished to $n = 1\cdot 27$. It would thus appear that at very high pressures γ becomes proportional to the pressure and c' becomes constant. Since c' depends also upon the density variation it is less valuable as a criterion than γ. For that reason the Gouy-Michelson method is not suitable for highly-explosive gases, as Ubbelohde and Koelliker showed in 1916; to avoid striking back of the flame, a high rate of gas feed has to be maintained in the tube, and turbulence sets in. H. B.

1614. *The Electrometric Method of Measuring Acidity and Alkalinity.* **W. T. Bovie.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 149–168, Jan., 1924.)—The author gives a brief *résumé* of the significance of determinations of hydrogen-ion concentration, and discusses the technique of the electrometric method, with especial reference to the various electrodes which can be employed. The author described a direct reading and direct recording potentiometer which he has devised for the measurement of pH values. This employs a semi-logarithmic scale, and electrometric titration curves are easily obtained in this manner. B. W. C.

1615. *Catalytic and Induced Reactions. Part I. Catalytic and Induced Oxidation in Presence of Salts of Cerium.* **A. K. Goard** and **E. K. Rideal.** (Roy. Soc., Proc. 105. pp. 135–148, Feb. 1, 1924.)—An electrode of special type is described which allows of the comparison of the potentials of certain substances behaving irreversibly towards the platinum electrode. By its means the action of cerous salts in effecting the induced oxidation of potassium arsenite, and the catalytic oxidation of five reducing sugars, have been investigated from the standpoint of the oxidation potential.

In the former case the potentials, in order of increasing oxygen pressure, follow the series: Cerous salt (inductor), arsenite (acceptor), equilibrium mixture, perceric salt, and in the latter case the series: Reducing sugar, cerous salt, perceric salt, these being in agreement with theoretical considerations. T. H. P.

1616. *Catalytic and Induced Reactions. Part II. Catalytic and Induced Oxidation in the Presence of Iron Salts.* **A. K. Goard** and **E. K. Rideal.** (Roy. Soc., Proc. 105. pp. 148–164, Feb. 1, 1924.)—So-called Schönbein's reaction, that is, the separation of iodine from potassium iodide solution in presence of hydrogen peroxide and a ferrous salt, is shown, on investigation from the standpoint of oxidation potential, to depend on the intermediate formation of an iron peroxide by the action of hydrogen peroxide on the ferrous salt. The decomposition of this peroxide has been followed by means of potential measurements and is found to obey a monomolecular law; electrometric titration shows that it has the formula Fe_2O_5. T. H. P.

1617. *Determination of Hydrogen-Ion Concentration by a Spectro-Photometric Method, and Absorption Spectra of Certain Indicators.* **W. R. Brode.** (Am. Chem. Soc., J. 46. pp. 581–596, March, 1924.)—In the study of the absorption spectra of dyes and other coloured organic substances in aqueous solution, it is necessary to know the hydrogen-ion concentration, which affects the shape and intensity of the absorption band. In order to obviate the necessity for a colorimeter or other special apparatus, a spectro-photometric method is suggested which requires no apparatus other than that used for measuring the absorption band.

It is found that change in the hydrogen-ion concentration of a dye solution is accompanied by gradual change, not of the wave-length, but of the height, of the absorption band. Similarly, the absorption bands of indicators do not change in wave-length with alteration in hydrogen-ion concentration but vary in intensity, while, in most cases, another band proceeds in the opposite direction at the same time. If the concentration of indicator is the same in all solutions, the hydrogen-ion concentration of an unknown solution may be determined by comparison of the height of its absorption band with those obtained from solutions of known hydrogen-ion concentrations. Any absorption due to the colour of the original solution may be counteracted by use of such solution in the comparison cell. T. H. P.

1618. *Hydrogen-Ion Concentration Measurements.* **W. T. Bovie.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 1235–1244, Dec., 1923.)—In a concentration cell with one constant and one variable electrode the e.m.f. is connected by a linear relation with $\log_{10}(1/C)$, where C is the hydrogen-ion concentration of the solution bathing the variable electrode. The rate of variation of the e.m.f. with $\log_{10}(1/C)$ depends on the temperature, and a potentiometer method is here described in which the sliding contact is arranged to read off the hydrogen ion concentration directly, and without using a separate scale for every temperature. Two forms are described. In one a galvanometer, in the other a quadrant electrometer, is used as the null instrument. The latter has the advantage that the cell is always an open circuit, and can therefore be made of any convenient smallness.

The sliding contact may be set at the hydrogen-ion concentration of the equivalent point in an electrometric titration, and alkali or acid added till the electrometer deflection is zero. This gives always a more rapid, and usually also a more precise indicator of equivalence than the most elaborate of colour methods. G. A. S.

1619. *A New Method for the Determination of the Potential of the Alkali Metals.* **G. Trümpler.** (Zeits. Elektrochem. 30. pp. 103–109, March, 1924.)—It is found that the potential of an alkali or alkaline earth metal may be measured against an aqueous solution if the metal is surrounded with a protective electrolyte, *i.e.* a layer of a solid salt of the metal in question. In the case of sodium, Thüringer glass was found to be a suitable material, and gave a value for the potential of the sodium of 2·72 volts, which agrees with the value derived by indirect methods. Experiments show that the glass behaves towards a saturated solution of sodium chloride practically as a sodium electrode. Further work is in progress using sodium chloride in place of the glass. B. W. C.

1620. *Critical Potentials of Hydrogen in Presence of Nickel Catalyst.* **A. W. Gauger.** (Am. Chem. Soc., J. 46. pp. 674–680, March, 1924.)—In order to obtain information on the nature of the adsorption of hydrogen by nickel, the ionisation and resonance potentials of hydrogen adsorbed on a nickel surface have been investigated. The method used involves the generation of radiation by electronic bombardment of the substance, impact of this radiation on a platinum plate producing a photoelectric current, which is studied as a function of the accelerating potentials applied to the electron causing the radiation. Discontinuity in the rate of increase of the photoelectric current is interpreted as an indication of the excitation of characteristic radiation. Seven critical potentials of hydrogen in the presence of nickel catalyst are determined in this way, four being attributed to the atom, two to the molecule, and one to the nickel-hydrogen complex. The results are regarded as indicative of the presence of atomic hydrogen in the system, hydrogen-nickel catalyst. T. H. P.

1621. *Electro-Titration with the Aid of the Air Electrode.* **N. H. Furman.** (Am. Electrochem. Soc., Trans. 43. pp. 79–86; Disc., 86–88, 1923.)—The author has extended his previous work on the use of the air electrode in electro-titration in the presence of strong oxidising agents [see Abstract 593 (1923)]. Mixtures of chromate and dichromate may be analysed in this manner. The method does not give an exact measurement of hydrogen-ion concentration, but is useful in relative determinations. Industrial applications of the air electrode in controlling processes are described. B. W. C.

1622. *Change in the Electromotive Force between a Metal Plate and a Solution on being Suddenly Brought into Contact.* **R. D. Kleeman** and **R. H. Bennett.** (Phys. Rev. 22. pp. 629–632, Dec., 1923.)—Experiments are described on various metals and solutions in which the e.m.f. development with time between a plate of metal immersed in a solution and another plate of the same metal introduced suddenly into the solution is noted. The results indicate that the process of establishing a p.d. between a metal plate and a solution possesses marked inertia, in agreement with the transition layer theory of the e.m.f. of a cell previously suggested. [See Abstract 235 (1923).] A. B. C. L.

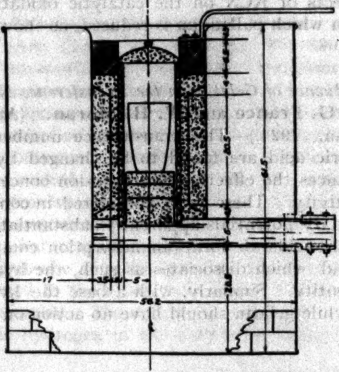
1623. *Potentials of Poisoned H-O Electrodes.* **N. Isgarischew** and **E. Koldaewa.** (Zeits. Elektrochem. 30. pp. 83–86, Feb., 1924.)—The authors place the platinised platinum electrode in a glass cell which contains sulphuric acid and is joined to a calomel electrode. The potential of the H electrode having been determined, the poison, also dissolved in sulphuric acid, is then introduced into the cell through a pipette. All the poisons tried, KCN, HCN, As_2O_3, H_2S, brucine, and quinine, reduced the potential (As_2O_3 the most, H_2S the least), but the potentials recovered in the course of several hours, most quickly with arsenious acid. The potentials of oxygen electrodes in caustic potash were similarly, and even more strongly, reduced by the poisons, but there was hardly any recovery. The effects are ascribed to the formation of compounds (not only hydrides and oxides), which are further to be investigated. Attention is drawn to the similar work of Sieverts and Lüeg [Zeits. Anorg. Chem. 126. p. 193 (1923)] and to the poisonous effects of KCN on the catalytic oxidation of PO_2H_3 by means of $PdCl_2$, in which palladium is reduced, as shown by A. N. Bach. H. B.

1624. *The Influence of Gelatin on the Transference Numbers of Hydrochloric Acid.* **W. G. France** and **W. H. Moran.** (Am. Chem. Soc., J. 46. pp. 19–30, Jan., 1924.)—The transference numbers for 0·1 M and 0·01 M hydrochloric acid are found to be changed by the addition of gelatin, which reduces the effective hydrogen-ion concentration and also alters the conductivity. These facts considered in conjunction with the value of the boundary potentials apparently substantiate the theory that gelatin reacts with acids to form an adsorption complex, or additive chemical compound which dissociates as such, the hydrogen ion of the acid losing its identity. Similarly, with a base the hydroxyl ion would lose its identity, while gelatin should have no action on a neutral salt. B. W. C.

1625. *Transference Numbers and Ionic Complexity of Hydrofluoric-Acid Solutions.* **C. W. Davies** and **L. J. Hudleston.** (Chem. Soc., J. 125. pp. 260–268, Jan., 1924.)—Determinations of transport numbers in solutions of hydrofluoric acid, ranging from 0·016 to 2·3 N show a uniform increase of the transport number of the anion from 0·13 to 0·338 as the concentration increases, Pick's assumption of the formation of a complex ion, HF_2', being thus confirmed. The equilibrium constant of the reaction, $HF + F' = HF_2'$ is found to be $K_2 = 4·7$, and the approximate value, 75, is derived for the mobility of the hydrofluoridion. The concentrations of the three ions over the above range of concentration of the acid have been determined. T. H. P.

1626. *Electrolytic Purification of Precipitates.* **A. Charriou.** (Comptes Rendus, 178. pp. 934–936, March 10, 1924.)—On subjection of an insoluble substance, holding absorbed a soluble substance, to the action of an electric current, the absorbed substance passes completely into solution and migrates towards the electrode of opposite sign to that which it itself bears. This phenomenon may be applied to the purification of precipitates from entrained salts. Thus, precipitated aluminium hydroxide may be freed from chromic acid, permanganic acid, sulphuric acid, lime or baryta, and ferric oxide from chromic acid. The method is, however, applicable only to precipitates which are completely insoluble, slightly soluble precipitates, such as barium sulphate, undergoing gradual dissociation and dissolution under the influence of the current. T. H. P.

1627. *Granular Carbon Resistance Furnaces.* **M. M. Austin.** (Indust. and Engin. Chem. 16. pp. 156–157, Feb., 1924.)—Two types of granular carbon furnaces are described which are adapted for laboratory use at temperatures of 1600° to 1700° C. In a vertical type as shown in the diagram, an enclosure 10 cm. in diameter and 15 cm. deep is heated uniformly by a current of 200 to 400 amps. at 30 to 70 volts. The lower electrode is bricked in as shown, leaving a central cylindrical opening 22·3 cm. in diameter and 35·5 cm. deep. The wood former is put in place making sure that it is centrally placed with respect to the depression cut in the lower electrode and a layer of very stiff alundum is rammed in about it to a depth of 25·5 cm. This cement can be put in so dry that the former can be removed immediately and the top and bottom of the lining shaped as indicated. The furnace is then dried as thoroughly as possible and the inner tube, resister material (consisting of carbon), and iron ring are inserted. Small amounts of the resister material should be filled at one time and worked down with a small rod. The inner tube must be centred so as to give a uniform section of carbon about it. A refractory support enables the crucible to be placed in the zone of maximum temperatures. A second type, which is described, is of a horizontal design. J. N. P.



1628. *Electrolytic Separation of Silver, Copper, and Bismuth by Graded Potentials.* **A. Lassieur.** (Comptes Rendus, 178. pp. 847–849, March 3, 1924.)—The separation of these metals has been effected in the Kling-Lassieur apparatus, following the procedure described in Abstract 1047 (1924). Silver and copper can be separated in nitric acid solution when a small amount of mercury is added to render the silver deposit adhesive. Silver and bismuth are easily separated in the same way if the auxiliary potential is rigorously controlled. Bismuth and copper are separated in ammoniacal solution, if the procedure described is closely followed. The above processes are especially satisfactory for analytical purposes. B. W. C.

1629. *Depolarisation of the Chlorine Electrode by Organic Compounds.* **M. A. Youtz.** (Am. Chem. Soc., J. 46. pp. 545–554, March, 1924.)—Anode decomposition potential measurements made with various organic compounds in potassium chloride or hydrochloric acid solution show little or no depolarisation to indicate chlorination of the substance, although at higher current-densities chlorination will occur. It is found possible to chlorinate acetic acid when mixed with HCl, using a carbon anode. The depolarisation observed at a Pt anode in such a mixture is shown to be due not to chlorination but to the different free energies of HCl in that solution and in water. When chlorine overvoltage is developed at a Pt anode and acetone, acetic acid, or other organic compounds are added, no potential drop occurs, showing no depolarisation is taking place. It is concluded that the anode decomposition method is unsuitable in deciding whether or not organic compounds can be chlorinated. B. W. C.

1630. *Electro-Chemistry of Acid Tin Baths.* **F. Halla.** (Zeits. Elektrochem. 30. pp. 124–138, March, 1924.)—The precipitation of tin from solutions containing hydrofluosilicic acid was studied. The dependence of the stanni-stanno, and the tin stanno potentials upon the acidity of the solutions was investigated. The current density-potential curves of tin in fluosilicic acid and other solutions were determined, and the influence of additions of other salt, and the depolarising effect of oxygen from the air were followed. The *rôle* played by the addition of boric acid, tartaric acid, formic acid, etc., to fluosilicic acid tin baths is explained by the action of colloids. From the variation of the potential, and the current density-potential curves in solutions, in which the stannous ions were oxidised by H_2O_2, it was shown that the velocity of oxidation of dilute Sn^{++} solutions was less than the velocity of decomposition of H_2O_2 by catalysis with smooth platinum. F. J. B.

1631. *Cataphoretic Migration of Suspended Particles.* **P. Debye** and **E. Hückel.** (Phys. Zeits. 25. pp. 49–52, Feb. 1, 1924.)—In an electric field of intensity X, small particles travel with a velocity V proportional to X. According to Helmholtz the particles will assume a potential ϕ against the liquid, and there will be electrostatic attraction or repulsion between the charge and the ions of the surrounding liquid in the ionic atmosphere, the space charges in which have been investigated by Gouy, Chapman, and by the authors [Abstract 2541 (1923)]. In many circumstances the distribution of the charges in that atmosphere is unimportant. But the field X would make the particle wander to the right and would also drive the atmosphere to the left, and the resulting V will be smaller than it would be in the absence of that atmosphere. The formula of Smoluchowski, $V = D\phi X/4\pi\eta$, is generally accepted, where D is the dielectric constant and η the friction constant of the liquid. V depends not only on the distribution of the charge in the atmosphere, but also on the shape of the particle. The authors prove mathematically that the formula only holds generally as long as the thickness of the atmosphere is small by comparison with the dimensions of the particle, and that the factor $1/4\pi$ cannot always have that value. For a cylinder $1/4\pi$ will be correct; for a sphere it should be $1/6\pi$. Concrete cases are not worked out. H. B.

1632. *The Influence of the Intermediate Oxides on the Electrolytic Short-Circuit Effect.* **C. F. Holmboe.** (Zeits. Elektrochem. 30. pp. 88–90, Feb., 1924.)—It is found that a film of nickel 0·05 mm. thick will practically eliminate the "passivity" of an iron anode in caustic soda solution. The short-circuit effects previously described [see Abstract 701 (1924)] are due to the formation of a superoxide at the surface of the anode during the electrolysis, which causes a current to flow when the cell is short-circuited. B. W. C.

1633. *Intermittent Current Electrolysis. Part III. The Measurement of Overvoltage.* **S. Glasstone.** (Chem. Soc., J. 125. pp. 250–260, Jan., 1924.)—The method used is that referred to in Abstract 705 (1924), lead being used as an electrode. The value of the potential of the polarised electrode was measured at known intervals after the polarising current was switched off. The results were plotted as potential/time curves, and the curves were extrapolated so as to obtain the value of the potential at the time of breaking the circuit, and hence the overvoltage at that moment. Results are given for both anodes and kathodes. At low current-densities the results obtained are almost identical with those obtained by the direct method, but with larger currents there is greater divergence. The author considers that the direct method is the most convenient one for the measurement of overvoltage. He is of opinion that the difference between the values obtained by the direct method and those by extrapolating is probably due to the existence of a metal-gas-electrolyte system situated at the surface of the electrode. The surface resistance at a lead electrode of 1 sq. cm. area in normal sodium hydroxide or normal sulphuric acid is not more than 4 ohms. The author is of the opinion that the existence of a "transfer resistance" which is very great at low current-densities is doubtful. W. R. C.

1634. *The Influence of Fluorides on Overvoltage.* **N. Isgarischew** and **D. Stepanow.** (Zeits. Elektrochem. 30. pp. 138–143, March, 1924.)—It is found that a maximum elevation of the overvoltage occurs at anodes of platinum, silver, gold, and carbon in sulphuric acid when the fluoride concentration reaches a certain definite value. This is due to the formation of a film of oxyfluoride on the surface of the metal, which, however, is dissolved when the fluoride concentration is increased. The discharge potential curves of platinum electrodes were investigated and the results indicate the formation of oxide-films of PtO_4, PtO_3, PtO_2, PtO; in the presence of fluorine, oxyfluorides are also formed. B. W. C.

1635. *Effect of Pressure on Overvoltage.* **S. J. Bircher** and **W. D. Harkins.** (Am. Chem. Soc., J. 45. pp. 2890–2898, Dec., 1923.)—The results of the experiments here described show that the effect of pressure on the potential of a kathode at which hydrogen is being liberated is in general very small at pressures between 760 mm. and 11 mm.; the slight changes which occur are due to bubble expansion and consequent shielding of the kathode and to increased stirring caused by the more rapid bubble liberation at low pressure. Overvoltage defined with reference to a reversible hydrogen electrode increases as the pressure is decreased, this increase being paralleled entirely by a decrease in the potential of the hydrogen electrode. Between 760 mm. and 11 mm. the range of variation of the overvoltage is about 50 millivolts.

The data obtained are discussed in relation to MacInnes and Adler's theory of overvoltage [Abstracts 359 and 973 (1919)], according to which $E = (3RT/2pr) . \gamma$, where E is the overvoltage, p the pressure in the bubbles, r their radius, and γ the surface tension of the liquid. These authors conclude that the bubble radius is practically constant for different pressures, so that the overvoltage should vary inversely as the pressure and thus increase very rapidly as low pressures are approached. The results now described indicate that the overvoltage increases with decrease of pressure only to the extent that the hydrogen electrode potential decreases, that is, as the logarithm of the pressure. The fact that earlier work in the authors' laboratory gave for a number of inactive metals the same temperature coefficient of overvoltage, which decreases by 2 millivolts per degree in 0·1N sulphuric acid seems to imply that the surface tension of the liquid is an important factor in overvoltage. According to the above facts, MacInnes and Adler's theory is a partial rather than a complete theory of overvoltage. The overvoltage at a mercury meniscus in dilute sulphuric acid increases as the large bubble at the top of the meniscus becomes larger and decreases suddenly when the bubble escapes. T. H. P.

1636. *The Dependence of Polarisation Overvoltage on Hydroxyl and Hydrogen-Ion Concentration. Part I. Antimony Kathode in Aqueous Alkaline Solution.* **H. J. S. Sand** and **E. J. Weeks.** (Chem. Soc., J. 125. pp. 160–168, Jan., 1924.)—The authors have extended their previous work on polarisation overvoltage of antimony kathodes (Chem. Soc., J. 1923, 123. 456). In alkaline solutions, this is determined by the equation $w = a - 2h$, in which h is the pH voltage, and a is a constant depending on the temperature. This is explained by the assumption that an ion $H(CH)_2$ exists which has a definite super-solubility limit. When a sufficient number of these ions have assembled, they will decompose simultaneously with the formation of a gas bubble, which is a satisfactory explanation of the observed facts. The conclusion is arrived at that the identical overvoltage – pH relation should be obtained for other metals which act as indifferent kathodes in alkaline solution. B. W. C.

1637. *The Preparation of Fused Zirconium.* **H. S. Cooper.** (Am. Electrochem. Soc., Trans. 43. pp. 215–225; Disc., 225–230, 1923.)—In the course of certain alloy investigations a considerable quantity of zirconium was needed to pursue the work, and its preparation in the laboratory became necessary. Although nothing novel is claimed for the process described, there are a number of interesting features and essential precautions involved in the production of the metal, which are considered of sufficient importance to be published in some detail. Experimental data relating to the melting-point of zirconium metal are also given, as well as a brief description of some new alloys. After consideration of the various methods employed in the past, it was decided to adopt the method, in which zirconium tetrachloride is reduced by sodium. The furnace used in the preparation of zirconium tetrachloride was of the horizontal, wire-bound tube type, in which temperatures up to 1000° C. are obtainable. The carbide was placed in silica or alundum boats approximately 3 × 6 × 1 in. deep. These boats held approximately 8 oz. of material each and were inserted in a fused silica tube which fitted snugly into the furnace. The diameter of this vitreosil tube was about 3 in. and the length about 3 ft. One end of the tube was fitted into a terra-cotta condenser by means of a thick rubber stopper. The other end of the condenser was also sealed with a rubber stopper of equal size, in the centre of which was an opening for the chlorine outlet tube. This condenser was approximately 12 in. in diameter by 18 in. long. After placing the carbide in the boats the tube was sealed and the current applied until a temperature of 500° C. was indicated by a thermo-electric pyrometer, the couple being adjacent to the outside wall of the silica tube. At this time a stream of chlorine was allowed to pass over the carbide, the temperature being held as close to 500° or 550° C. as possible, since this seems to be the best temperature from the standpoint of selective separation of the iron.

The furnace used for the reduction of the zirconium tetrachloride was 21½ in. in height, and had an outside diameter of 6 in. It consisted of two parts, the upper containing the periscope for observing the temperature of the reaction, and a tube connecting with the vacuum pump. The lower part of the furnace consisted essentially of a cylindrical tube having an inside diameter of 5 in. and ½-in. wall, to which a base is welded, the upper part having a 5-in. opening with a welded steel collar. The height of the cylinder was 13 in. and the collar 1⅝ in. in diameter. Just below this collar is a threaded plug in which the terminals are placed to conduct the current to the inside of the cylinder. A lead gasket was used between the top and the base to make an absolutely air-tight joint. The heating unit consisted of an alundum core wound with nichrome, and was 2⅛ in. inside diameter by 9 in. long. Between the outside wall of this core and the steel shell the space was insulated with sand. The steel cylinders in which the zirconium tetrachloride and sodium were packed, were 8¼ in. long by 1¾ in. in diameter, and were provided with screw tops. Dense crystalline zirconium tetrachloride only was employed to make the metal, since it was more permanent in air and permitted a greater weight of material to be used per charge, due to the smaller volume. The amount of chloride and sodium used for each reaction was based upon the equation: $ZrCl_4 + 2Na_2 = 4NaCl + Zr$. The theoretical amounts would therefore be 232 g. of chloride plus 92 g. of sodium, this yielding about 90 g. of metal. In actual practice 230 g. of chloride and 92 g. of sodium were used, as the slight excess of the sodium can be easily washed out, and a complete reduction of the tetrachloride was thus assured.

Zirconium chloride and sodium in the proportions given above were rapidly placed in alternate layers in the iron cylinder, the cap was tightly screwed on, and the cylinder inserted in the furnace. The furnace top was then bolted tightly on, and the cylinder exhausted. At this stage the current was applied and within a short time a temperature of 500° to 600° C. was reached. Close observation at this point showed a sudden rise in temperature, the cylinder reaching about 900° to 1000° C. It was held at this temperature for a short time, the current was turned off, and when the cylinder had become cold the pump was cut off and the furnace opened. If this procedure be carefully followed, metal having the following approximate percentage analysis will be obtained: Zr 99·28, Fe 0·14, Ti 0·13, Si 0·07, Total 99·62. The metal suffers little loss either in concentrated or in dilute hydrochloric or nitric acid, even when boiled therein. It is also practically insoluble in dilute sulphuric acid, but dissolves completely in boiling concentrated sulphuric acid. J. B. C. K.

1638. *Electrolytic Oxidation of Eugenol.* **A. Lowy** and **Catherine M. Moore.** (Am. Electrochem. Soc., Trans. 42. pp. 273–284, 1922.)—Contrary to the claim of Ger. Pat 92007 (1897), no appreciable proportion of vanillin could be obtained by the electrolytic oxidation of isoeugenol. The latter is highly susceptible to oxidation to a wide variety of possible products and vanillin itself is readily oxidised electrolytically. T. H. P.

1639. *Electrolytic and Chemical Chlorination of Benzene.* **A. Lowy** and **H. S. Frank.** (Am. Electrochem. Soc., Trans. 43. pp. 107–117, 1923.)—Benzene may be chlorinated by stirring it with either hydrochloric acid or aqueous sodium chloride and electrolysing the mixture. The yield of chlorobenzene is increased by introduction of iodine as a carrier and by increase of the temperature up to 60°, and is affected by the efficiency of the stirring. The quantity of more highly chlorinated products formed generally increases as the temperature is raised, and the amount of benzene decomposed to carbon dioxide by anodic oxidation increases at the same time. The proportion of product insoluble in alkali increases rapidly with increase in the current-density. In the chemical chlorination of benzene water acts as a carrier, no substitution taking place when dry chlorine is passed into dry benzene, although additive products are then formed. T. H. P.

1640. *Electrolytic Deposition of Nickel in Disperse Form.* **F. Thorén.** (Zeits. Elektrochem. 30. pp. 20–29, Jan., 1924.)—In order to study the properties and sizes of the nickel particles deposited from solutions at various concentrations and kathode current-densities as well as the kathode potentials, the authors surround a wire of nickel, 3 mm. in diameter, in a solution of nickel nitrate (neutral or ammoniacal) with a tubular anode of nickel foil, through which the electrolyte is drawn downwards by a stirrer. The electrodes are stationary; the kathode is previously etched with alkali and nitric acid. The deposit obtained is scraped off the kathode by means of filter paper and examined; the kathode is then etched again for a new experiment. The concentration ranged from 0·005 to 0·1n and the current-density from 2 up to 1600 milliamps. per sq. cm. The author distinguishes two main types of deposits: a homogeneous, hard grey and adhesive deposit, and a dark-black soft disperse deposit of egg-shaped particles; the deposits were never crystalline; some nickel hydrate was also deposited. The current-density at which the deposit becomes disperse (inversion) increases with increasing nickel concentration and is smaller in ammoniacal than in neutral solutions. The size of the particles ranged from 0·3 to 2·5 μ, increasing for each concentration with increasing current-density to a maximum, then falling off or remaining constant. The differences between the two types are not due to different sizes of particles. The changes in the appearance go more or less together with the evolution of hydrogen which, however, may set in before or after the visible changes. Ammonia is also liberated at high current-densities, even from neutral solutions. When a change takes place the potential of the kathode becomes more negative by 0·08 volt. To determine this potential another cell arrangement has, however, to be used, intermittent currents being applied, as le Blanc had done in the study of ammonium amalgams. H. B.

1641. *Formation of Iodide of Hydrogen by the Silent Discharge.* **E. Warburg.** (Zeits. f. Physik, 21. 6. pp. 372–380, 1924.)—To explain the phenomena bringing about chemical action in the silent discharge quantitative experiments are necessary, so that the amount of chemical action and its dependence upon the physical conditions can be measured. In the present paper the formation of HI from I_2 and H_2 is dealt with. A current of hydrogen charged with iodine vapour is led through a Siemens tube and the ratio of the HI formed to the I_2 entering the tube in dependence upon the vapour pressure of the iodine, on the velocity of the gas current, as well as on the p.d. and current, is measured. The observations are carried out at three different temperatures: (*a*) Room temperature, (*b*) 30° C., and (*c*) 40° C. It is shown by the results obtained that the current not only causes HI to be formed, but also decomposes HI. This result is discussed, making the assumption that the formation of HI is proportional to the I_2 concentration. The results obtained are compared with those obtained using other gases in the silent discharge in Siemens tubes. A. E. G.

1642. *The Electrolytic Production of Chlorate with a Chromium-Coated Kathode.* **G. Grube** and **A. Burkhardt.** (Zeits. Elektrochem. 30. pp. 67–72, Feb., 1924.)—The kathodic reduction of the hypochlorite and chlorate produced by the electrolysis of alkali chlorides without the use of a diaphragm is almost entirely prevented by the use of a kathode coated with chromium, probably owing to the protective action of the oxidation products of chromium which are formed. A rough surface is better than a polished one for this purpose. The technical application of this method will depend upon the durability and adhesiveness of the chromium coating, which is deposited on iron electrodes by a specially devised process. B. W. C.

1643. *Preparation of 3 : 3′-Diaminodiphenylsulphone by Electrolytic Reduction of 3 : 3′-Dinitrodiphenylsulphone.* **J. Lacroix.** (Comptes Rendus, 178. pp. 483–486, Jan. 28, 1924.)—This reduction gives a 94·5 % yield when an alcoholic solution of the dinitro-compound acidified with hydrochloric acid is used as the kathode liquid and the kathode consists of nickel foil covered with spongy tin, the anode being of lead and immersed in 10 % sulphuric acid. The kathode liquid is kept in agitation and at 68–72°. T. H. P.

1644. *Electrolysis of Potassium Oleate.* **G. W. F. Holroyd** and **J. E. W. Rhodes.** (Chem. Soc., J. 125. pp. 438–442, Feb., 1924.)—Determination of the "apparent transport number" for the negative ion of potassium oleate gives the value of 0·725 in 0·2N solution at 15–16°. This high value renders it probable that potassium is present in an anion involved in the electrolysis. The principal product formed at the anode consists of oleic acid. T. H. P.